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An assessment of the shipboard training effectiveness of the Integrated Damage Control Training Technology (IDCTT) version 3.0

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THESIS

AN ASSESSMENT OF THE SHIPBOARD TRAINING EFFECTIVENESS OF THE INTEGRATED DAMAGE CONTROL TRAINING TECHNOLOGY (IDCTT) VERSION 3.0

by

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March 1998

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The ability of a ship's crew to control damage is a critical measure of readiness for U. S. Navy. ships. Proficiency in this area is largely a function of routine shipboard training. Since damage control skills tend to be perishable if not continuously practiced, shipboard personnel must have an effective means of exercising damage control skills. Computer-based technologies that utilize the advantages of interactive courseware (ICW) present training opportunities that challenge the traditional methods of shipboard training. The Integrated Damage Control Training Technology (IDCTT) is an application of ICW that allows shipboard repair teams to exercise their damage control skills continuously. The trainer was installed onboard USS Harpers Ferry (LSD-49) and evaluated as a stand-alone training device through administration of opinion surveys and comparison to various aspects of full-scale drills with a standardized performance evaluation system. The shipboard IDCTT was found to be an effective shipboard training device that saves time. Additionally, it has significant cross-training and team-building qualities that can be integrated into an existing damage control training program.

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ABSTRACT

The ability of a ship's crew to control damage is a critical measure of readiness for U. S. Navy ships. Proficiency in this area is largely a function of routine shipboard training. Since damage control skills tend to be perishable if not continuously practiced, shipboard personnel must have an effective means of exercising damage control skills. Computer-based technologies that utilize the advantages of interactive courseware (ICW) present training opportunities that challenge the traditional methods of shipboard training. The Integrated Damage Control Training Technology (IDCTT) is an application of ICW that allows shipboard repair teams to exercise their damage control skills continuously. The trainer was installed onboard USS Harpers Ferry (LSD-49) and evaluated as a stand-alone training device through administration of opinion surveys and comparison to various aspects of full-scale drills with a standardized performance evaluation system. The shipboard IDCTT was found to be an effective shipboard training device that saves time. Additionally, it has significant cross-training and team-building qualities that can be integrated into an existing damage control training program.

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I. INTRODUCTION

A. OVERVIEW

Since the design of the earliest man-of-war, it has been expected that warships would venture into harm's way. Consequently, the United States Navy has experienced its share of combat on the high seas. As such, repeated victory has been captured through determination to mission accomplishment and firm emphasis on survival and damage control.

The ability to control damage is a critical measure of readiness for all naval ships. Proficiency in damage control is possible only through continuous quality onboard training that creatively stimulates actual conditions of an emergency at sea. The imposition of realistic damage control scenarios is the challenge presented to shipboard training teams. They are tasked with conducting drills that sharpen the decision-making aptitude of damage control supervisors and exercise the physical skills of repair party members.

Conventional methods of damage control training onboard naval ships require thorough preparation and time to execute a drill that provides constructive training feedback to repair parties. However, the quality of training typically becomes a function of the time management skills on the part of the Damage Control Training Team (DCTT). Even so, with the use of training technologies, this burden can be alleviated through utilization of interactive courseware (ICW).

The Integrated Damage Control Training Technology (IDCTT) is an example of realistic computer-based video technology that reduces the time required to train key

decision-makers in the onboard damage control organization. The shipboard version of IDCTT (version 3.0) links the Damage Control Assistant (DCA) with the Repair Party Leader (RPL) via the ship's local area network (LAN) to create an interactive environment for these trainees to experience real-time scenarios complete with alarms, reports, ship system configuration changes, and consequences of both trainees' actions.

This thesis addresses the training value of the ICW associated with the IDCTT version 3.0; it examines the shipboard training effectiveness of IDCTT version 3.0 in the course of a chemical, biological, and radiological (CBR) training scenario. Also, the impact of the potential time savings when continuously utilizing this technology to train the ship's DCA, RPLs , and Duty Engineers is considered.

In this chapter, I focus on damage control fundamentals and their relationship to a typical damage control organization. Then, I discuss the implications of ICW as an effective medium for damage control training when applied to decision-making in a stressful environment. Next, specific characteristics of the IDCTT version 3.0 are outlined. Finally, I discuss present shipboard training methods and the challenge they currently present to shipboard personnel. In follow-on chapters, a comparison will be made between DCA/RPL training value during the course of a typical CBR drill and the training value when utilizing IDCTT version 3.0. The methodology and data analysis that is performed in this study answers the following research questions:

- When compared to conventional training methods through the use of standardized watchstander performance measures, is the IDCTT version 3.0 an effective shipboard damage control trainer? Does it save time?

- Based on crewmember interviews and surveys, are there dimensions of the IDCTT version 3.0 that should be improved?

- How will the IDCTT version 3.0 become integrated into a shipboard damage control training continuum?

- Does the IDCTT version 3.0 provide a team training approach for the DCA and RPL?

B. BACKGROUND

The United States will continue to maintain a forward presence in unfriendly regions of the world for the foreseeable future. Our commitment to global economic and humanitarian concerns mandates that we dispatch naval forces to areas where there is high regional instability and a significant threat of hostility. At the same time, the environment in which ships operate has changed from blue water, where defense in depth was achieved through long range detection and engagement, to littorals with little time to detect and engage the enemy. To meet these demands, U. S. Navy warships are increasingly deployed within battle groups that are tasked to patrol greater geographical areas with fewer ships.[1] Consequently, more and more small surface combatants are operating independently in remote regions without the continuous protection of battle group defensive assets. Ship self-defense has always been important, however, its priority has increased since mission accomplishment of these independent units depends on their ability to remain in commission with maximum offensive capability.

The possibility of striking a mine, experiencing attack by multiple anti-ship cruise missiles (ASCM), and exposure to chemical weapons is continuing to increase as under-

[1] The battle group is the basic unit in which naval ships deploy. An aircraft carrier is the center of battle group operations. It is supported by cruisers, destroyers, frigates, amphibious ships, logistical support ships, and numerous aircraft.

developed nations gain access to these technologies. The changing nature of the threat in conjunction with restricted rules of engagement will continue to force the U. S. Navy to operate in harsh environments where ships may have to take the first hit prior to retaliation. Certainly, the enormous political and human cost of losing a United States Ship in the third world is unacceptable.

It is vital that the U. S. Navy continue to assess the survivability of its deployed units in these regions. Moreover, damage control expertise must remain a top priority for the successful implementation of national policy as sanctioned by naval forces. The IDCTT Trainer will allow key members of the onboard damage control organization to maintain proficiency as critical decision-making leaders who understand the need for accurate damage assessment and repair priorities so that the ship can continue to fight.

1. Total Ship Survivability

The IDCTT was specifically designed under the concept of Total Ship Survivability (TSS). This is a philosophy that demands rapid repair and primary focus on ship's systems that provide offensive capability. It takes damage control the next step from mere afloat survival to battle damage perseverance with come-back assault on enemy forces. The advanced electronics and extensive complexity of today's modern warships has made them more susceptible to battle damage than in the past. For this reason, the damage control focus is on saving the ship while restoring its combat functionality. This concept requires that each individual know what systems are involved in vital combat and engineering functions. Thus, training for TSS emphasizes the integration of damage control, combat systems and engineering organizations (Weaver, 1995). The IDCTT will train DCAs and

RPLs to keep this objective as their central goal. In doing so, they assist the tactical watchstanders in direct support of ship's mission accomplishment.

To accommodate the TSS training philosophy, decision trees have been built into the IDCTT training scenarios that represent the various degrading states of the ship based on the natural course of the problem and trainees' actions. These are combined to form a training algorithm that represents the spread of damage over time in accordance with the logical and expected events that would occur (Alleley,1997).

2. Ship Survivability

The survivability of a surface combatant may be thought of in terms of susceptibility and vulnerability, and is defined as its capability to avoid and/or withstand a man-made hostile environment. Susceptibility is purely a measure of the probability of the ship being hit by an enemy's weapon. Here, naval architecture, tactics, and weapon systems are the major factors that influence a ship's actual success in meeting and defeating a hostile threat. Vulnerability, on the other hand, refers to the ship's fate after experiencing a failed attempt at self-defense (OPNAVINST 9070.1,1988). Accordingly, the readiness of the ship in this post-hit condition is vitally linked to the ability of critical components to operate after damage, damage control system design features, and crew training. Upon getting underway, a ship may be assumed to possess a state of vulnerability that has been built in through engineering design. However, the issue of crew training, when discussing vulnerability, presents a dynamic feature of readiness that may be continuously improved, thus having great impact on the ship's recoverability. Damage control training, therefore, will have a direct influence on the degree to which the ship is restored to its pre-damage capabilities.

OPNAV Instruction 9070.1 defines U. S. Navy policy regarding ship survivability. It emphasizes that specific survivability levels will be incorporated into ship design as a fundamental requirement no less significant than other inherent ship characteristics. For example, level III survivability is necessary for all aircraft carriers and battle force combatants. As illustrated in Table 1, this stipulation stresses that these ships must endure the most severe combat environment; incorporating all survivability levels in addition to dealing with the broad degrading effects of damage from ASCMs, torpedoes, and mines. Although this instruction articulates the necessary degree of survivability, it presses the reader to interpret recoverability issues based upon personal experience and opinion. A post-hit capability requirement that states "after a hit from weapon of type X, the ship shall retain the ability to perform Y" is necessary so that onboard damage control training efforts may be geared toward these recoverability objectives, thus enhancing ships survivability (Calvano, 1997).

Table 1: Surface Ship Survivability Levels.

Ship Survivability Levels Defined:		
Level I	Low	**Least severe environment**; excludes need for enhanced survivability; must include seakeeping, shock hardening, individual CBR protection, DC/FF ability to control and recover from conflagrations and ability to operate in high latitudes.
Level II	Moderate	**Provide ability for sustained combat operations following weapons impact**; must include level I plus primary and support system redundancy, improved structural integrity and subdivision, frag protection, radar signature reduction, and blast protection.
Level III	High	**Most severe environment for Battle Group combatants**; must include level II plus ability to deal with broad degrading effects of damage from ASCMs, torpedoes, and mines.

Source: OPNAVINST 9070.1 "Surface Ship Survivability" 23 September 1988.

Improved ship design will certainly reduce vulnerability but since we will never be 100 percent sure where damage will be incurred, design is not a guarantee of negligible vulnerability. Onboard damage control training must fill the gap between realistic and affordable design and an acceptable level of vulnerability.

3. Continuous Shipboard Training

The necessity for an effective shipboard damage control training continuum cannot be overemphasized. The returns to a strong commitment in this area are numerous when weighed against the potential consequences of its neglect. A ship's training cycle is broken down into three distinct levels of proficiency. These phases of training: basic, intermediate, and advanced/repetitive, are conducted prior to the ship's deployment and consist of approximately eighteen months of training time. A Command Assessment of Readiness and Training (CART) is a two-phase process intended to be a comprehensive review of readiness (COMNAVSURFLANT/PAC, 1993). Phase one (CART I) is conducted while on deployment and its product is a training plan for the interdeployment cycle. Phase two (CART II) is conducted in the basic training phase after completion of the interdeployment cycle maintenance periods. Its purpose is to review crew mission area proficiency and establish training priorities.[2] The Tailored Ship Training Availability (TSTA) is executed in four phases that demonstrate expanding levels of unit readiness. Ships systematically integrate into a battle group where they ultimately become certified within the Composite

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[2] Examples of ship mission areas are: Anti-Submarine Warfare, Anti-Air Warfare, Anti-Surface Warfare, Strike Warfare, and Naval Surface Fire Support.

Warfare Commander (CWC) framework.[3] After a Final Evaluation Period (FEP) in the basic phase, the intermediate training phase demands a Composite Training Unit Exercise (COMPTUEX) where ships work in units of two or more and interactively focus on their primary and secondary mission areas. A Joint Task Force Exercise is conducted in the advanced phase where all battle group warfare skills are evaluated. Table 2 illustrates the significant shipboard training evolutions that are conducted within each phase. While the majority of crew team-training requirements are fulfilled prior to the basic phase, primarily through shore-based training facilities, the maintenance of proficiency for all watchstanders is the ship's responsibility.

Table 2: Breakdown of a Typical Ship's Training Cycle.

Major Events Within A Ships Training Cycle:		
Basic Phase	Intermediate Phase	Advanced Phase
CART II TSTA I TSTA II TSTA III TSTA IV FEP	COMPTUEX	JTFEX

Source: Commander, Naval Surface Force Atlantic/Pacific Instruction 3502.2A "Surface Force Training Manual" 26 November 1993.

Damage control team training and firefighting team training are required once every twenty four months or upon forty-percent turnover of repair locker teams. Also, general shipboard firefighting training is required only every six years for all personnel

[3] The Composite Warfare Commander (CWC) oversees all mission area commanders within the battle group. For example, the Anti-Submarine Warfare Commander (ASWC), Anti-Air Warfare Commander (AAWC), and Anti-Surface Warfare Commander (ASUWC) are responsible for their respective mission areas. However, they provide input to the CWC.

(COMNAVSURFLANT/PACINST 3502.2A, 1993). Finally, DCAs and RPLs receive training for those billets just once prior to being assigned. Consequently, it is incumbent upon ship's force to provide realistic repetitive training in the interim between schoolhouse qualification and deployment to a real-world hostile environment. Type commanders have delineated this requirement to ships since it makes sense to train on the platforms they will fight. There is great value to total familiarization of systems, equipment, and unique shipboard characteristics when experiencing crisis and uncertainty. Quality onboard damage control training as a matter of routine will enhance a readiness posture capable of successfully overcoming contingencies and restoring the ships offensive capability.

4. Damage Control Fundamentals

To grasp fully the potential of the IDCTT version 3.0, a brief discussion of damage control fundamentals will amplify its robust applicability in the accomplishment of onboard training objectives.

There are two primary overall objectives to damage control: take all practical preliminary measures before damage occurs, to prevent it, and limit damage when it does occur (Gritzen, 1980). Since the ship's ability to inflict punishment upon an enemy may depend on the effectiveness of damage control, efforts toward restoration of mission essential systems and combat readiness posture must be approached as an offensive as well as defensive function. Therefore, for effective execution of damage control measures, shipboard personnel must possess detailed knowledge of ship construction characteristics, compartmentation, stability, and onboard damage control equipment. Accordingly, successful damage control efforts will only be realized when prompt corrective action is

taken, using available materials, by personnel who are thoroughly proficient in damage control practices, and who maintain a keen understanding of overall damage control objectives.

The key personnel are decision-makers; they are primarily the DCA and the RPL. While the DCA must obtain all available information concerning the nature and extent of damage, there is a strong dependence upon the leaders of repair parties to provide this information. Since the RPL is in close proximity to the scene of damage, a prime vantage point is attained to supply dependable, accurate information to the DCA in Damage Control Central (DCC). Ascertainment of critical information in a central location is vital in maintaining an overall picture of readiness and to provide direction for further progress toward correction. However, it is equally vital that action be taken automatically at the repair locker while advising DCC of repair party progress. Any delay could result in the spread of damage and cascading degradation of combat readiness.

There is little doubt that the DCA and the RPL are critical decision-making entities of the damage control organization. The quality of their training is directly related to the ability of the ship to control damage. Their skills and thought processes must be sharp and well refined. They must be thoroughly exercised in a multitude of possible scenarios that will force them to interactively solve problems with limited or damaged resources. Together, they must aggressively act, assess, prioritize, and systematically direct action to contain damage and smoothly transition a crisis situation from boisterous confusion to poised confidence in the ship's ability to sustain damage and uphold tactical potency.

a. Tactics

A shipboard mass conflagration or main space fire involves many concerns for damage control parties. An unorganized approach in attacking such a situation would almost guarantee omission of important milestones that are necessary for stabilizing such a volatile environment. The basic tactics in controlling massive fires onboard naval vessels are well defined in the Naval Ships Technical Manual, Chapter 555. Initial actions, fire attack, fire extinguishment, hose and nozzle handling, and fire overhaul are the broad areas in which firefighting efforts must concentrate to ensure a systematic methodology in crisis management. Each of these broad areas are broken down into multiple tasks that shipboard fire parties are specifically trained to perform (Table 3).

The CBR environment also presents many concerns for the damage control organization. Tactics for controlling the spread of chemical agents and conducting post-exposure cleanup are outlined in chapter eleven of Naval Warfare Publication (NWP) 3-20.31. This publication defines intensifying levels of protective posture that will minimize ship and personnel contamination to chemical weapons. Mission Oriented Protective Posture (MOPP) levels establish the specific actions that must be completed so that personnel may function effectively, yet maintain the desired level of ship-wide protection. In the CBR environment, damage control teams must focus their efforts in this manner to ensure a concrete system of situational control. Each MOPP level may be considered an overall objective that is reduced to specific tasks for which shipboard personnel are prepared to conduct. Table 4 summarizes these tasks. The coordination of all tasks and the logical flow of events, however, is the responsibility of the DCA with the close partnership of the

RPL. They must prioritize, expedite, and direct repair party efforts in order to proceed rapidly from the early response phases of a contingency through the final details of clean-up actions. Without this overview perspective, the battle for crisis stabilization could easily stall in a single objective or neglect an aspect of recovery that is critical for survival.

Table 3: Breakdown of Overall Firefighting Objectives.

Specific Tasks Within Broad Firefighting Objectives:	
BROAD OBJECTIVES	**SPECIFIC TASKS**
Initial actions.	Report the leak. Man AFFF stations. Isolate/deflect the leak. Activate AFFF bilge sprinkling. Set positive ventilation. Obtain EEBD, portable F/F equipment.
Fire attack.	Report the fire. Size up the fire. Evacuate the space (if necessary). Man repair lockers. Activate halon/bilge sprinkling. Isolate the space (mech./elect.). Set fire boundaries.
Fire extinguishment.	Reenter the space. Activate bilge sprinkling. Locate the fire. Report the fire out. Set reflash watch.
Hose and nozzle handling.	Fake out properly. Move effectively in the space. Demonstrate proper personnel spacing. Direct F/F agent correctly. Communicate effectively.
Fire overhaul.	Locate/extinguish all hang fires. Wash fuel into bilge. Desmoke/ventilate the space. Gas free the space.

Source: NavSea, NSTM Chapter 555, Shipboard Firefighting. June 1993.

Table 4: Breakdown of Overall CBR Defense Objectives.

Specific Tasks Within Broad CBR Objectives:	
BROAD OBJECTIVES	**SPECIFIC TASKS**
MOPP-1	Inspect monitoring systems. Issue protective gear. Inventory medical supplies. Assign personnel to CBR teams. Set material condition Yoke. Set readiness condition III.
MOPP-2	Wear personal mask in carrier. Pre-position CBR equipment. Test CMWDS. Test alarms. Post M8/M9 paper. Set up AN/KAS-1. Set material condition Zebra.
MOPP-3	Don personal protective clothing. Issue medical supplies. Activate CMWDS intermittently. Man AN/KAS-1. Monitor CAPDS. Activate CPS. Set General Quarters. Activate CCA/Decon stations.
MOPP-4	Activate CMWDS continuously. Personnel don masks and gloves. Set Circle William. Implement mandatory water drinking.
Decontamination	Conduct int./ext. surveys. Dispatch decontamination teams. Decontaminate personnel.

Source: Naval Warfare Publications Library, "NWP 3-20.31, Surface ship Survivability." December 1995.

5. Damage Control Organization

Throughout this thesis, numerous references are made to titles and responsibilities

of specific members of the damage control organization. It is essential that the reader possess a basic understanding of these relationships to gain fully from the discussion of the IDCTT trainer. Therefore, a brief discussion of a typical shipboard damage control organization follows to heighten comprehension of this standardized structure. The actual structure of personnel assigned to DCC and repair lockers is defined as well as the reporting responsibilities that are critical for the overall objectives of damage containment to be achieved.

a. Damage Control Officer

The Damage Control Officer (DCO), who is typically the ship's Engineer Officer has the responsibility of overall damage control readiness. Fire party qualifications, Damage Control Petty Officer training, damage control equipment maintenance, and fire prevention are daily concerns in the undertaking to maximize overall damage control capability. He/She is responsible to the Commanding Officer (CO) and musters the assistance of several commissioned officers and senior enlisted damage control experts.

b. Damage Control Assistant

The Damage Control Assistant (DCA) is primarily responsible to the DCO for all damage control matters. This officer's vast administrative duties include drill scheduling, qualification tracking, and procurement and accountability of portable damage control equipment. However, operationally the DCA is the central member of the underway damage control organization and reports directly to the Officer of the Deck (OOD). All damage reports from repair lockers funnel through the DCA in the course of an emergency. He/She is completely in charge of stabilizing a crisis, containing damage, and directing

restoration efforts through the use of a communication network that extends from DCC to repair lockers and other peripheries where personnel take immediate actions then report their progress.

Figure 1 illustrates the underway damage control organization. Here, command by negation allows the DCA to oversee repair party efforts while projecting possible shortfalls in the achievement of overall objectives.

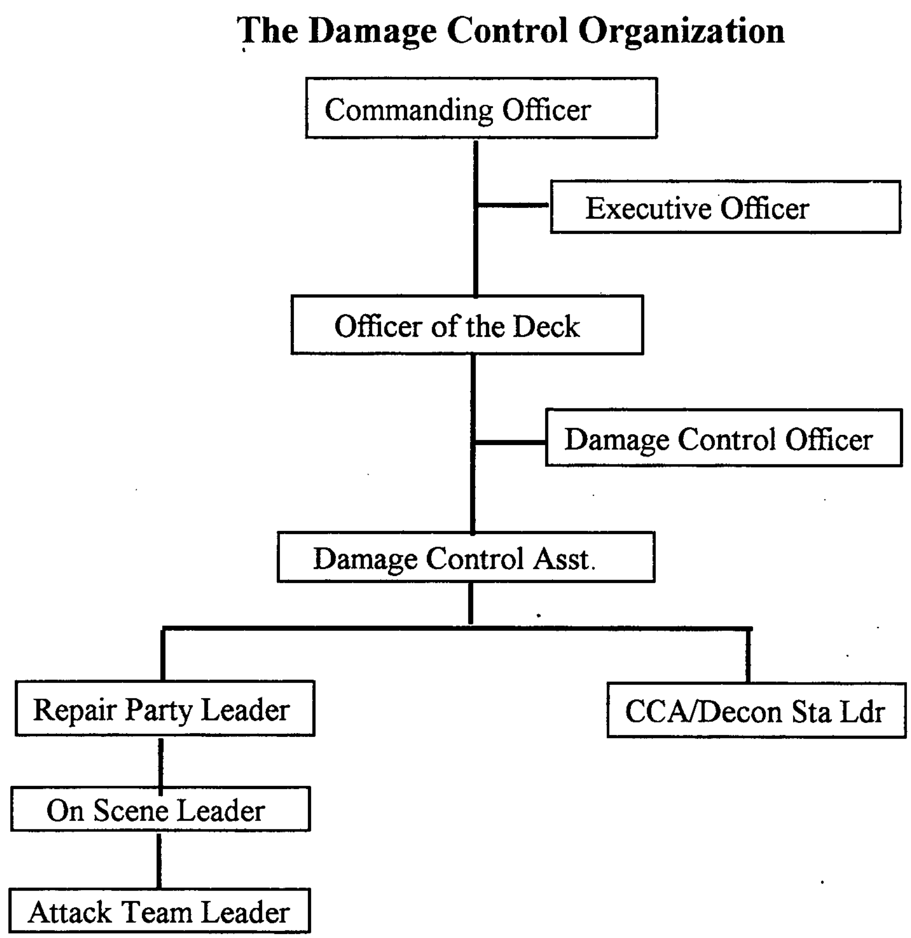

Figure 1: Simplified Ship Damage Control Organization

c. Damage Control Central

The primary purpose of Damage Control Central (DCC) is to collect and compare reports from the various repair parties in order to assess the condition of the ship and determine action that should be taken. As reports are received, graphic records of the damage are made on large damage control diagrams. For example, reports concerning flooding are recorded on ship diagrams that portray liquid distribution before damage. With this information, the stability and buoyancy of the ship can be estimated, and the necessary corrective measures determined. Orders can then be given for that specific action. In addition to damage control diagrams, numerous publications containing relevant ship characteristics and design features are located in DCC. Personnel refer to these books when making decisions about compartment isolation and system alignments. Finally, the damage control console located in DCC features vast temperature and pressure alarms and indicators and allows operation of fire pumps, vent fan motors, and firemain isolation valves from a remote location.

(1) Phone Talkers. Reliable communication between DCC, repair lockers, and the bridge is maintained through sound power phone circuits that are manned by qualified phone talkers. They pass direction from the DCA and solicit reports from the scene to inform the DCA of current repair status. Normally, there is a designated phone talker for each repair locker and one in communication with the bridge (underway) or the quarterdeck (inport). They typically use wire-free communication (WIFCOM) radios or portable phone lines as back-up measures in the event of damage to installed circuits. The

phone talker's skill in facilitating the flow of information to and from the DCA is vital in the overall repair efforts.

(2) Plotters. Without documentation and display of incoming information, the DCA would have great difficulty in assessing the state of readiness throughout the ship. Therefore, plotters assigned to DCC track status reports by graphically updating ship drawings that are posted in view of the DCA. With standardized notation, details of mechanical and electrical space isolation, status of the fire and flooding, and firefighters' breathing expiration times are readily available for assessment and direction to RPLs.

(3) Damage Control Console Operator. Remote sensors throughout the ship provide input to electronic displays on the damage control console. This console is manned by an operator who primarily informs the DCA of alarm indications and current firemain pressure. This watchstander also takes direction from the DCA to start/stop fire pumps and open/close various isolation valves throughout the firemain and fuel oil transfer systems.

d. Repair Party Leader

The Repair Party Leader (RPL) coordinates all damage control actions in an assigned area of the ship. Reports are received from the On Scene Leader (OSL) and Investigators. Simultaneously, the RPL makes reports to the DCA in DCC and keeps track of all actions by plotting them on damage control diagrams in his repair locker.

On a typical combatant there are generally three zones of responsibility that contain repair lockers with assigned damage control personnel. Repair II is responsible for

the forward portion of the ship. Repair III is responsible for the aft section, and Repair V is primarily responsible for the ship's engineering spaces. The RPLs in these sectors are usually officers or chief petty officers who must act promptly and decisively to contain damage within their are of responsibility. And so, their actions must be proactive as the situation will normally mandate timely demonstration of effective leadership under pressure.

e. ***Repair Locker***

The majority of damage control portable equipment is stowed in a repair locker and its adjacent passageways. In the event of an emergency, repair party personnel will proceed to their assigned repair locker, dress out in firefighters gear, and make initial preparations for a worst case situation. In addition to functioning as an issue point, the repair locker will provide the RPL with a command and control location. A phone talker and plotter will perform in unison with their counterparts in DCC. Key members of the repair party, the OSL and attack team leader (ATL), will take initial direction from the RPL in the repair locker. Then, they will proceed to the scene of damage, establish communications with the repair locker, and take necessary action to contain damage.

(1) On Scene Leader. Time-critical events and accurate reports are the obligation of the On Scene Leader (OSL). This experienced petty officer is tasked with directing the ATL's actions and informing the RPL of repair progress. Furthermore, the OSL must provide the ATL with the best possible conditions within which to operate. For example, there must be prompt space mechanical and electrical isolation, sufficient firefighting agent (i.e., Aqueous Foam Forming Fluid, Purple Potassium Powder, firemain water), and reliefs for in-space personnel when exposure times have been reached. The OSL

is in the optimal position to make initial assessments of the situation and to determine methods of attack concerning space reentry (i.e., single or double hose attack, direct or indirect attack).

(2) Attack Team Leader. Visibility within a damaged space will be minimal since fire causes smoke and toxic gasses to deny the firefighters of all optic ability. Consequently, the Attack Team Leader (ATL), outfitted with a Naval Firefighter Thermal Imager (NFTI), will accompany the hose teams into the affected space. The NFTI is utilized to locate the fire, then direct the nozzlemen by issuing hose commands to extinguish the blaze. If a double hose attack is employed, the ATL must balance their efforts in order to maximize the strengths of such a technique. Meanwhile, reports to the OSL are the essential ingredients to the RPL and DCA's vision of the overall state of damage control.

(3) Investigators. While the repair party provides the primary response to damage, investigators establish a means to check surrounding areas for the spread of degradation to the ship. They roam freely to survey areas adjacent to the affected compartments, and make reports to the OSL and RPL. When the situation requires, additional repair locker personnel can be dispatched to an area to reinforce structural supports with shoring or limit flooding with pipe patching equipment.[4] Additionally, investigator reports are vital in the determination of installed damage control system effectiveness.

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[4] Shoring refers to the damage control procedure of installing structural reinforcement where there is a possibility of bulkheads or decks collapsing. Numerous techniques are employed including a system of triangulation or horizontal support where a strongback distributes pressure along the affected structure.

f. Contamination Control Area/Decontamination Station

In the event of a chemical attack, there will eventually come a time when decisions must be made about the necessity of decontaminating external areas of the ship. To facilitate the transition of personnel from within the skin of the ship, where presumably there is little to no contamination, to the weather deck, where contamination is known to exist, a Contamination Control Area (CCA) and Decontamination Station must be established. The CCA is a designated area between the weather decks and Decontamination Station where personnel will dispose of their CBR suits, protective boots, and gloves. A CCA should be established for each twenty five personnel onboard, or provisions made for the decontamination and resupply of the CCA after each group of twenty five personnel are processed (NWP 3-20.31, 1995). The Decontamination Station is the area where personnel will be physically evaluated for contamination, then washed down and decontaminated if necessary.

(1) Survey Teams. Locating the actual contamination, both internally and externally, is the first step to ship-wide decontamination. For this reason, survey teams are sent out to all areas of the ship to conduct chemical agent monitoring. This time-consuming procedure will result in a determination of priorities for which to begin the overall decontamination process.

(2) Decontamination Teams. There are several options when physically decontaminating a ship. Weathering, Counter Measure Wash Down (CMWD), chemical neutralization, fire hose flush, and scrubbing are among the common alternatives for expelling lingering CBR residue. The most common method, however, is scrubbing

followed by fire hose flush since it is so absolute. Consequently, this requires extensive manpower and tight control of the CCA and Decontamination Station.

6. Shipboard Damage Control Training Requirements

The Surface Force Training Manual clearly defines the required shipboard damage control training exercises that must be conducted throughout the various training phases of a ship's cycle. The complexity of these drills spans from setting material condition zebra to conducting a mass conflagration exercise.[5] Table 5 is an outline of representative shipboard drills required during specified phases of training. As an afloat command progresses through its deployment workup cycle, it must successfully demonstrate and report its damage control readiness through the achievement of an "M" rating.[6] This informs the battle group commander of a specific unit's skillfulness and proficiency within the damage control arena.

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[5] Material condition Zebra is the maximum state of physical readiness that may be assumed. Doors, hatches, scuttles, and numerous zebra-classified valves are secured so that the ship is completely watertight throughout. A mass conflagration exercise is a comprehensive battle scenario that imposes cascading effects of an enemy attack. It is a ship wide evolution that may last for several hours and involves all shipboard organizations and personnel.

[6] Readiness ratings range from M-1 to M-4 and are assigned to each ship mission area. When a ship is fully ready to deploy, it has achieved an M-1 rating in all mission areas. Deficiencies within a mission area may result in a readiness rating being reset to M-4 and will normally form the basis of a unit's interdeployment training cycle. Depending on the ship's training schedule, readiness ratings will progress from M-4 through M-1 by the time the ship is scheduled to deploy.

Table 5: Required Shipboard Exercises.

Shipboard exercises within training phases		
PHASE	**EXERCISE**	**DESCRIPTION**
Basic	MOB-D-11-SF MOB-D-13-SF MOB-D-15-SF	Set material condition Shoring Chemical attack
Intermediate	MOB-D-23-SF MOB-D-24-SF MOB-D-27-SF	Locate D.C fittings Darken ship Helo crash firefighting
Advanced/Repetitive	MOB-D-8-SF MOB-D-9-SF MOB-D-12-SF	Major conflagration Main space fire fighting Underwater hull damage

Source: Commander, Naval Surface Force Atlantic/Pacific Instruction 3502.2A "Surface Force Training Manual" 26 November 1993.

Onboard drills serve more than just a display of readiness. They also provide an opportunity for individual personnel to gain further watchstation qualification. For example, an ATL may qualify as an OSL after performing as the OSL under the supervision of a qualified DCTT member during a specified number of drills. Hence, the Personnel Qualification Standard (PQS) system defines all necessary prerequisites and practical requirements for sailors to achieve onboard watch qualifications. Since naval personnel transfer to and from their commands throughout the calender year, there is a significant challenge to shipboard leaders in maintaining battle team cohesiveness. Consequently, the achievement of sustained repair party qualification requires close management by identifying and tracking personnel shortfalls and planned rotations. Therefore, damage control readiness can only be maintained through an aggressive drill plan that strives for a maximum number of drills as opposed to the minimum required to achieve deployment standards.

7. Reduced Manning

The inevitability of future surface combatant ships with reduced manning levels has been realized through the exploits of the Navy's Smartship Program. The USS Yorktown (CG-48) and USS Rushmore (LSD-47) have been significantly modified to maximize existing installed equipment capabilities and to incorporate new technologies in an effort to reduce the size of the crew. It is currently estimated that a saving of $1.7 million per ship per year could be achieved in personnel costs through Smartship initiatives. With the reduction of maintenance requirements and watchstanding duties, the ship's Watch, Quarter, and Station Bill was modified to allow fewer personnel to be on watch at a given time.[7] This "core watch" is expected to react only to operational conditions or provide immediate response. Then, it will draw from a support matrix of additional qualified watchstanders to perform narrower mission-specific operational requirements. Also, routine shipboard maintenance activities have been delegated to a large "day worker" force rather than being the responsibility of watchstanders. For example, shifting on-line machinery and cleaning filters will be done by non-watchstanding personnel (Rushton, 1997).

As expected, there is a significant impact on the damage control organization when the crew size is reduced. In fact, the 124-man Ticonderoga Class shipboard damage control organization, which is based upon lessons learned in shipboard firefighting and battle damage control in World War II, was reduced to 64 personnel. Interestingly, it was found that nearly half of Yorktown's damage control personnel were dedicated to command and

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[7] The Watch, Quarter, and Station Bill is the shipboard document that clearly defines where all crewmembers must be physically located during different conditions of readiness.

control functions. These command and control procedures have been retooled with greater reliance placed upon key personnel, such as the DCA and RPL, for the successful achievement of damage control (Rushton, 1997).

Certainly, the quality of training received by crewmembers will play an even more significant role in damage control readiness within an organization of reduced numbers. They will also be assisted by technologies including the Damage Control System (DCS), which utilizes commercial off the shelf (COTS) computer resources. Through sensors and actuators, this system accommodates the monitoring, command, and control tasks of shipboard damage control. DCS includes embedded doctrine for main engineering space firefighting, provides new control capability to sectionalize the firemain and chill water systems, and posts updated damage control status information on the ship's LAN. Additionally, the DCS will retain the fire pump and fire zone control capability of the damage control console it replaces (Miller, 1997).

8. Organizing With Reduced Manning

Since fewer crewmembers will be available to respond to a casualty, priority must be given to the action these personnel will take. Therefore, it is possible that the long-standing view of general quarters (GQ) with respect to damage control may have to change. Some aspect of the damage control organization will have to be adjusted based on the lesser number of repair party personnel. However, since the bottom line in damage control is hose teams, shoring details, and de-flooding squads, these manpower-intensive units will likely remain our number one resources (Rushton, 1997). But, their points of origin do not necessarily have to be where we are accustomed to seeing them respond. Here again, the

USS Yorktown (CG-48) has written a new chapter in the book of change. Traditionally, personnel are assigned to a repair locker, then respond to an emergency within their zone of responsibility. Yorktown has identified specific rapid response teams for unique types of damage within their repair locker zones. This means that only the necessary personnel report to a repair locker, dress out, equip themselves with the appropriate portable damage control gear, then proceed to the scene of damage. The repair locker is merely an issue point that remains unmanned. The RPL proceeds to the scene and coordinates actions with the DCA. These personnel come from any shipboard division and are specifically qualified as repair party members. Our culture tells us that engineers must man Repair V to fight main space fires. Yorktown has shown us that all sailors are firefighters by drawing from the entire crew to man fly-away squads that are qualified to respond to all types of damage. This was proven during Yorktown's 1996 work up cycle with the George Washington Battle Group where during CART II and TSTA II engineering assessments fire parties were manned and ready to reenter a main engineroom within fifteen minutes of a simulated main space fire being imposed.

C. COMPUTER-BASED TRAINING TECHNOLOGY

The personal computer revolution has brought about a opportunity for organizations to enhance training quality and sophistication through the use of computer technology. Its applications include drill and practice, tutorial dialog, intelligent tutoring systems, tutorial simulations, interactive multimedia instruction, and other approaches that modify information presentation to meet the needs of the individual learner. All of these uses are

referred to as Computer-based Instruction (CBI). Numerous studies have been conducted that explore design, development, use, and evaluation of military applications of CBI. Significant insight has been gained through these research efforts for which military training has improved to keep pace with the ever-increasing complexity of military technology.

1. Need for CBI

The swelling array of advanced systems onboard naval ships has demanded that human performance in the operation and maintenance of these platforms continue to improve. Simultaneously, limitations in time, funding, personnel, and other resources have made the accomplishment of continuous quality training a serious challenge to military personnel. For this reason, military trainers are pursuing the use of computers in all dimensions of training (Fletcher, 1995). Since it is unlikely that excess resources will be available in the future to conduct training missions, personnel readiness must be achieved though alternate means. By taking advantage of CBI, training efficiency may be realized through exploitation of its unique features.

2. Individualization

Individuals who are taught in classrooms compared to those who receive one-on-one instruction experience a difference in actual learning by up to two standard deviations (Fletcher, 1995). This diversity may be the result of numerous factors. However, the media richness of such personalization certainly contributes to the student's attention level and motivation to retain information. Certainly, providing private instructors for all naval personnel through all phases of their career training is economically impossible. Instead, computers can replace some of this individualization. With advancing technology, a more

advantageous instructor-to-student ratio is becoming required to meet the Navy's school command training objectives. Subsequently, individual tailored training is rapidly becoming a necessity for shipboard personnel to remain proficient in the operation of our most sophisticated warships. By bridging this need with customized CBI, training sequence, content, and pace are matched to meet the individual requirements by applying a classic economic solution; we are substituting the capital of CBI for the labor of human instructors (Fletcher, 1995).

3. Effectiveness

A common approach to assessing the effectiveness of an educational technology is meta-analysis. This method quantitatively combines the results of many studies into a single parameter known as effect size. The effect size is a way of describing the overall effectiveness of some particular approach to education or training. Specifically, it is a measure of the standard deviations of difference between two particular methods. For instance, two groups of individuals could be compared where one group is subjected to training with an instructional technology and its performance is evaluated while using this technology. The second group's performance would be evaluated using conventional training methods. Performance may be measured by graded exercises or written examinations. The effect size is then calculated by dividing the difference of the two performance means by an estimate of the standard deviation of their combined distributions. For this example, the larger the effect size the greater the effectiveness of using CBI.

Effect size may also be viewed as a measure of the extent to which the performance of 50th percentile students (equivalent to .50 or half a standard deviation) may be raised or

lowered by some experimental training technology. Table 6 summarizes the effect size of numerous studies conducted at various education levels. Note the effect size of .40 in military training. This suggests a rise in student performance from 50th percentile to 66th percentile when CBI technology has been utilized (Fletcher, 1995). An example of this is an increase in the performance of naval aviators when landing aircraft onboard ships, from average to slightly above average, after experiencing an experimental computer-based flight simulation trainer.

Table 6: Effect Sizes When Considering the Use of CBI in Educational Instruction.

Some Effect Sizes for CBI			
Where	**Effect Size**	**No. Of Studies**	**50%tile to __%tile**
Elementary School	0.47	28	68%tile
Secondary School	0.42	42	66%tile
Higher Education	0.26	101	60%tile
Adult Education	0.42	24	66%tile
Military Training	0.40	38	66%tile
Overall	0.39	233	65%tile

Source: Fletcher, J.D., Effectiveness and Cost of Interactive Videodisc Instruction in Defense training and Education. (Institute for Defense Analysis, July 1990), IDA P-2372.

4. Advantages of CBI

The implementation of CBI systems, could provide the military with a more cost effective means to support personnel training. CBI is particularly well suited where large amounts of practice are required to master the subject matter. It simulates environments that often must be reproduced for the student to try different tactics while repeatedly observing the consequences associated with them (Fletcher, 1990). Unlike video-based distance

learning, where distributed classroom materials is typically the focus, CBI can be delivered inexpensively and presented at arbitrary times and places (Fletcher, 1990). Finally, the outcomes of most CBI training systems are standardized; there is normally an assessment capability built into the system that allows modification of subject presentation based on student needs. Therefore, students are more likely to achieve criterion levels of performance when CBI is used rather than conventional classroom techniques where students may continuously repeat subject matter that is already understood (Fletcher, 1995) .

5. Interactive Courseware

While computerized learning technologies have made a revolutionary impact on the learning process, earlier program designs were actually quite limited in reaching their full potential. They normally allowed limited student control over the instructional sequence and presented predetermined drills with preprogrammed answers and comments (Bass, 1997). Nevertheless, upgrade packages with advanced capabilities have led to greater interactivity between the user and the technology. Interactive courseware (ICW) incorporates instructional content with a wide capacity to access illustrations and photographs, sound and video, and large amounts of text. Since system outputs and scenario consequences depend on trainee input, an interactive training environment is created. The trainee must physically remain engaged with the medium via keyboard or mouse, to complete a training scenario. With increased interactivity and student control, storage and retrieval of instructional content allows for a "reader-centered" environment. Here, the reader controls the experience by selecting among multiple choices, choosing unique paths, and sequencing through materials.

The key factor of ICW is the ability to navigate through material in whatever ways are most meaningful to the individual users (Bass, 1997).

ICW is defined by Military Handbook (MIL-HDBK) 1379-1 and MIL-HDBK-284 Part 3, respectively, as follows:

> ICW is a computer controlled courseware that relies on trainee input to determine the pace, sequencing, and content of training delivery using more than one type of medium to convey the content of instruction. ICW can link a combination of media to include but not limited to; programmed instruction, video tapes, slides, film, television, text, graphics, digital audio, animation, and up to full motion video to enhance the learning process.
>
> ICW is a term referring to any type of computerized instruction characterized by the ability of a trainee to respond through an input device. ICW may be an integral part of computer based instruction (CBI), computer assisted instruction (CAI), or a computer based training (CBT) program.

This software engineering technology has the capacity to deliver large amounts of material in multiple forms through an interactive environment that allows users to control the flow of events. As a commanding media tool, ICW enhances manipulation of these materials through a variety of powerful linking, sorting, and annotating activities. As a result, these activities are made to reinforce intellectual skills in addition to satisfying certain cognitive needs for quality learning such as the ability to follow through links at the immediate moment when curiosity is aroused, and the ability to view different forms of the same information side-by-side (Bass, 1997).

Various levels of ICW technology can range from complex stand-alone applications that require CD-ROM for delivery, to compact training programs that can be distributed on a single floppy disk or over the INTERNET. The major differences are the degree to which they vary in interactivity between the student and the instructional material, the instructional

strategies employed, the amount of feedback the student receives, and the amount of student control over the sequencing of instructional content (Office of Training Technology, 1996).

D. TEAM BEHAVIORS

The successful mission execution of a naval warship is the culmination of massive engineering efforts merged with extensive human resources development. Any lack of focus on the latter will surely starve a warship of its viability and responsiveness. While individual sailors comprise a crew, it is the subgrouping of these individuals into teams that allows a ship to display diverse "personalities" as it conducts multiple tasks. Since most naval operations depend upon the integrated performance of teams of individuals, who must coordinate their activities in order to contribute to unit performance, team training is a vital interest area in fleet readiness. The transferability of team-learned skills from the schoolhouse setting to the operational unit is critical. Then, the maintenance of team proficiency is required for the afloat unit to remain a deployable asset. Therefore, it is important that we understand how teams behave as an integral unit.

Past studies of team behaviors have focused primarily on static descriptor variables such as task characteristic, team size, and team structure, rather than on process variables such as leadership styles, communication, and interactivity among people performing operational tasks. In fact, research shows that a common conceptualization of a team is the relationship in which people use work procedures to make possible their interactions with machines, machine procedures, and other people in their pursuit of system objectives. There has historically been a concentration on the machine aspects of team training and a disregard

for the person-to-person interactions and adaptations. Socio-technical systems theory strongly suggests that both dimensions should be developed fully in order to optimize the contribution of each to an organization. Any disdain for one category will likely result in degraded team performance (Morgan, 1986).

Shipboard training effectiveness is influenced by the attention that is given to the process variables inherent to a specific team. Trainers can facilitate team development and performance by keying on these elements. Teams that are kept largely intact throughout a ships deployment cycle, with consistency of individuals filling critical positions, are expected to out-perform a team that is disjointed with changing personnel (Morgan, 1986). Repetition in team training is the element of effectiveness. Additionally, team demographics (i.e., rank, years of experience) can be used to the advantage of team performance. For example, an enlisted RPL may be inhibited to correct the actions of the DCA, however, if a team relationship is developed, they will view a situation as a unit with a common objective. Effective communication is achieved since status barriers are nonexistent throughout the duration of a crisis and all interaction is in the spirit of mission accomplishment (Morgan, 1986). By virtue of the damage control organization there is no question of leadership roles while the team has capitalized on the strengths of all members through the empowerment of subordinate personnel.

1. Team Decision Making

One specific team behavior is its ability to make collective decisions, then remain confident that the decision is sound. Eventual action may be easier than the actual decision making function. Carl Von Clausewitz, in his classic military writing, On War, explains that

the assessment of surroundings, determination of necessary action, and steadfast adherence to a contingency plan, despite conflicting reports and dissension among subordinates, is the most difficult task of a commander. Arguably, the same pressures are felt at all levels of decision-making. In a team environment, however, the commanders' strain can be eased by tapping a group's collective power and intelligence. Although the responsibility remains with the senior officer, the tools that are used in plotting a course of action are not limited to personal intuitions. With strong team identity and a conceptual connection to a "team mind," a team can lead to more creative solutions to problems, a richer assessment of a situation, and a greater ability to handle a wider range of factors during deliberation and contingency planning. It is difficult to envision a single person possessing equal thinking capacity while working alone (Zsambok,. 1992).

IDCTT version 3.0 is a training system that captures the inputs of the DCA and RPL to formulate collective solutions to overwhelming circumstances. The team make-up of the damage control organization is not new, nor are the relationships between its members. However, IDCTT version 3.0 provides a forum in which these individuals can further enhance their teamwork skills. Exercised repetition between them should accelerate their team growth and continue to improve proficiency. Consequently, more effective damage control decisions can be made through better communication and greater coordination.

E. DECISION MAKING UNDER STRESS

There is little controversy that a war fighting scenario onboard a naval vessel is a stressful environment. Rapid response and clear thinking become difficult when affected by

the outside influences of such hazardous surroundings. The U. S. Navy has recognized these pressures upon key decision-makers and has taken steps to enhance the information processing skills of these watchstanders.

Recently, there has been a shift in military focus to the Crisis and Limited Warfare (CALOW) environment. Shipboard watch team members are often expected to process and synthesize vast amounts of data rapidly before a decision, involving some action, can be reached. When individual team members experience an overload in their ability to evaluate this volume of information, their performance breaks down. Even a slight error due to the degradation of a single individual's performance could potentially manifest itself to the pivotal decision-maker on the watchteam (Dwyer, 1992). For example, if the air search radar operator fails to recognize just one potentially hostile air track, substantial time could be lost before that same track appears on the Weapons Control Officer's (WCO) radar console. Consequently, more time will be wasted with track correlation, contact resolution, and consultation between the WCO and the air search radar operator. By the time the Tactical Action Officer (TAO) is aware of the confusion there will be minimal time to take action against the hostile threat. Obviously, the consequences of this cascading mistake could be catastrophic if defensive shipboard weapons release is not conducted in a timely manner.

Ambient stresses to the watchstander are common forces that must be handled properly. Increasing engineering sophistication of modern naval ships coupled with the demands of a CALOW environment can easily drive a watchstander's information processing ability into overload. These factors, in conjunction with inherent realities of time

compression, information ambiguity, and fatigue all contribute to potential disaster if individuals are not prepared to meet these demands.

1. Tactical Decision Making Under Stress

In light of the above circumstances, the Tactical Decision Making Under Stress (TADMUS) research program was introduced. Its intent is to minimize the performance degradation of shipboard watchstanders in stressful environments (Dwyer, 1992). The program has resulted in a computer-based trainer developed by the Naval Training Systems Center that is configurable for teams or individual operators. Different skill levels are selectable for novice, apprentice, or journeyman users. A computer monitor provides a mock radar scope on the left and a function menu for contact type and classification on the right. Trainees use a three-button trackball and cross hair to select "radar contacts" for which textual information is then displayed. The system is comprised of three primary modules: The exercise generating system, the execution system, and the measurement system. The setting of the TADMUS model is a typical shipboard Combat Information Center (CIC) with emphasis on the detect-to-engage sequence that is common within the anti-air warfare environment. Here, detection, identification, and action are the vital components of the CIC watchteam's decision-making process. They must be done sequentially and rapidly even though numerous outside counter forces will be working to produce a dense fog of war (Howard, 1983).

The theoretical basis for TADMUS is largely a function of the actual conceptualization of information processing:

> Individuals assimilate information through automatic or control processes. In essence, automatic processes are attention-free. They are the

methods used for dealing with highly consistent, routine operations. In order for a task to be performed under an automatic processing mechanism, a large number of repetitions is usually required during skill acquisition. Control processes, on the other hand, are activated for new or unexpected operations. The control process mechanism places significant demand on the individual's attentional capacity if successful performance is to result (Dwyer, 1992).

With this in mind, it is imperative that shipboard training be conducted frequently with realistic scenarios placing individuals in stressful situations. Only then, can these watchstanders become prepared to utilize automatic processes rather than become overloaded when depending on control processes. Consequently, the intervention of outside stressors should not have the same decremental impact upon individual performance.

It has been concluded that the functional fidelity of the TADMUS model is quite high. Examination of stress multiplying issues relating to personnel thought processes have highlighted the overall awareness of their degrading effects. The realism and task transferability to real world situations have provided a versatile tool to assess user performance when subjected to stress. Additionally, its impact on training philosophy has positively affected instructional strategies in most other areas of shipboard training (Dwyer, 1992).

a. Application to IDCTT

There are numerous parallels between the TADMUS model and the IDCTT trainer. Instead of the TAO in the "hot seat," the DCA is burdened with gathering information via emergency reports (detecting), prioritizing the impact of damage on all ships' systems (identifying), and taking action to minimize the spread of damage (acting). Just like the TAO, the DCA will receive ambiguous and conflict information; the pace of

events will be just as fast and dynamic; and, the consequences of his workload oppression will be equally as serious.

IDCTT presents the decision-maker with a scenario of achievable objectives based on logical task accomplishment. However, when stress factors are injected through multimedia computer technology, the pressure to complete the scenario increases dramatically. IDCTT system characteristics and capabilities are explored in further detail to enhance an understanding of its operation and potential for shipboard damage control training.

F. HISTORY OF IDCTT

The cost, time, and resource availability associated with damage control exercises have often imposed severe limitations to this much-needed training. Consequently, naval leaders have been driven to implement a more cost effective, highly efficient medium from which to prepare shipboard personnel for emergencies. This impetus has resulted in the research and development efforts of a multi-disciplined group consisting of education professionals, experienced multimedia developers, subject matter experts, and other technical personnel. The outcome of their endeavors was the prototype version of IDCTT.

This multimedia technology was presented at the CNO Firefighting / Damage Control Conference in Norfolk, VA. in November 1993. Subsequently, it was installed at the Surface Warfare Officer School (SWOS) in Newport, RI as well as at the Afloat Training Group Pacific (ATGPAC) in San Diego, CA. Its training capabilities and educational value have been evaluated by afloat instructors and through a Naval Postgraduate School Masters

Thesis. The acceptance of this trainer in the fleet and academia has been overwhelming. However, since IDCTT was developed as a prototype it became evident that its limitations would not allow full realization of its maximum potential. For this reason, the Naval Sea Systems Command (NAVSEA) has enhanced the IDCTT trainer to extend its capabilities (Malloy, 1996).

1. System Upgrades

With a solid foundation in the original version, the new trainer has built on this technology by incorporating DCA and RPL training in an actual shipboard environment. The software modifications and additional scenarios expand the capacity of the original trainer to emerge as a powerfully networked shipboard version with many new features. These new features were recommended after an overall technology evaluation was conducted to determine options that best facilitate quality training. They include: digital video, flexible scenarios, interactive network capability, embedded training, and instructor scenario planning. According to the trainers' software developers:

> The technology to be implemented in subsequent releases of the IDCTT software shall break through the current limitations to provide multiple scenarios for a greater number of damage control personnel. It shall offer the capability to lead the trainee through a different set of events with each new training session. Instructors shall have the capability to configure the training module to fit the needs of the students (Malloy, 1996).

By utilizing newer technologies, IDCTT engineers emphasize the advantages of such system upgrades in their explanation of some of the significant cost savings associated with newer versions:

> It shall implement the latest modeling and simulation technology to reduce costs of full-lifecycle development, increasing the scenario flexibility and system scalability. Finally, IDCTT shall break away from the older

analog video used in the initial version and implement cutting-edge digital technology, thereby eliminating the need for uncommon and costly laser disc hardware (Malloy, 1996).

Since the latest version of IDCTT is a shipboard application, it is incorporated as a training module embedded in the ship's Damage Control System (DCS). Its commercial off the shelf (COTS) packaging coupled with its interface with the DCS allows dual use of the system hardware for damage control information exchange and for access to IDCTT as an embedded trainer.

An additional upgrade to the system is its Scenario Generator. This is a tool provided to the training instructors in their creation or training scenarios. Its primary inputs are actual scenario scripts and scenario description files. These files, presented as menus, are basically paths the instructor can take in developing a scenario. They define actions available to the student and identify appropriate programmable scenario changes based on student action or non-action. This added capability allows training personnel several options in tailoring training to specific individual needs.

2. Additional Features

The shipboard version of IDCTT utilizes the proven assets of the previous models. Its most predominant characteristics are its graphical user interface (GUI), and the plotter workstation display.

a. Graphical User Interface

This interface between the trainee and the damage control scenario allows for rapid response to changing shipboard circumstances. Through the use of a mouse and a seventeen inch monitor, the trainee may solicit desired damage reports, make status reports,

and order action to subordinate damage control personnel. This is a significant change from the prototype version of IDCTT, which incorporated a touch-screen monitor that was considered, by trainees, to be too slow in allowing user inputs. These orders are displayed as a menu of options used by the trainee to combat the damage. The monitor's upper left portion depicts video images of damage control watchstanders making various reports based on the scenario. These video images are unique scenes that are tailored to fit specific ship classes. The upper right portion of the screen illustrates the ship's forward and aft firemain pressure, Collective Protection System (CPS) zone pressures (DCA display), in addition to the ship's list and heel, and pull down menus for draft and engineering plant status reports. The lower left section of the screen displays all incoming reports and orders together with trainee generated reports and orders. Finally, the lower right portion of the display is a complete menu-driven listing of options available to the trainee. This is where the trainee will focus all actions throughout the training scenario.

b. Plotter Workstation Display

The networking capability of IDCTT version 3.0 allows the use of an additional display specifically for the damage control plotter. This monitor will display just the damage control reports that are generated throughout a scenario. The plotter may then present this information on the ship's damage control diagrams in a manner that is familiar to the DCA and RPL.

3. IDCTT Trainer Hardware

Through the integration of the latest multimedia technology, IDCTT combines a personal computer, monitor, printer, sound card with speakers, video display card, and CD-

ROM digital video to simulate realistic conditions that the DCA and RPL would experience while fighting cascading shipboard damage. The following is a description of the specific system components and their applications:

a. IBM Compatible Personal Computer

A Pentium central processing unit is the hardware basis of the IDCTT system. This processor is responsible for the event time line that continuously updates the training scenario based on the trainee inputs.

b. Computer Monitor

The system uses a seventeen-inch color monitor. This is the medium for which the GUI provides visual stimulation to the trainee. As described above, all graphical system output is displayed here for input to trainee decision-making and action.

c. Printer

A laser printer receives preprogrammed graphic output from the personal computer providing the trainee with damage control chits. They are printed out and available for review of scenario event sequence and as a backup to the scenario voice reports and orders.

d. CD-ROM

The CD-ROM provides scenario audio input such as alarm sirens and background noise. Additionally, it provides all digital video images to the system monitor. These images graphically depict shipboard personnel providing information to the DCA and RPL. Also, they display personnel responding to orders given by the DCA and RPL in reaction to the crisis environment.

e. Sound Card and Speakers

The speakers used in the IDCTT trainer provide stereo sound via input from the sound card programmed with digital samples of real-world sound blended with audio signals from the CD-ROM. The combination of realistic background sound synchronized with video imagery creates the stress inducing excitement that demands the trainee's quick reaction in a simulated emergency environment.

f. Video Display Card

A video display card provides the graphics required to create the sharp video images presented to the trainee. A minimum of one megabyte of video RAM is necessary to accommodate the thousands of colors at an acceptable resolution for satisfactory system operation.

g. Network Card or Modem

The unique feature of IDCTT version 3.0 is its ability to simultaneously train two watchstanders interactively. A network card or modem is necessary to provide this interface between trainees. Through this device, information is passed from one training station to another to allow communication between watchstanders as they progress through a scenario.

4. IDCTT Trainer Software

The entire software package containing the IDCTT program requires three gigabytes of storage space. It is written to function with Windows NT or Windows 95 as its operating system. The presentation of a Windows environment furnishes the user with a familiar setting to view system operations and capabilities. In addition to easy navigation with icons,

pull-down menus, and dialog boxes the system capitalizes on an advanced methodology called object oriented technology. This focuses on different objects within an application domain and provides behavior to those objects. Thus, the desired functionality is gained. This approach in software engineering is highly conducive to the ever-changing requirements of an evolving software system (Malloy, 1996).

5. IDCTT Trainer Teaching Points

The shipboard version of IDCTT was installed onboard USS Harpers Ferry (LSD-49). This radically new training capability provides this ship with a computer-driven medium to prepare damage control personnel for the eventualities of shipboard contingencies. An understanding of the trainer's teaching points is necessary to realize its full efficacy.

Specific training objectives have been built into the trainer to focus on damage control fundamentals as they relate to real-world situations. Such underlying components of survival will magnify the probability that shipboard personnel will conduct themselves in a manner that results in mission accomplishment. When surrounding circumstances are degrading and unclear, they will fall back on the key concepts, which are the basic teaching points incorporated in the IDCTT. Appendix A outlines these teaching points with justification of their relevance.

G. PRESENT SHIPBOARD TRAINING TECHNIQUES

Shipboard drills and mass conflagration exercises give onboard personnel experience in controlling damage that may be imposed upon their ship during enemy engagement. An

effective drill requires detailed planning, realistic simulation, timely execution, and constructive feedback to damage control team members. Furthermore, this type of repetitive rehearsal for emergency action is the manner in which all schoolhouse learning objectives are reinforced in the fleet. Practical application of academic concepts is vital in the development of an inexperienced trainee into a proficient performer. For this reason, shipboard emergency drills are routinely conducted to flex the crew and maintain overall damage control readiness. With its personnel demands and encompassing nature, a chemical weapons defense exercise provides an excellent opportunity for which to evaluate the effectiveness of the IDCTT version 3.0. Therefore, a brief description of the objectives and conduct of a CBR drill is summarized below.

1. CBR Drill Objectives

The five fundamental categories of objectives for minimizing exposure to chemical, biological, and radiological elements, as characterized in NWP 3-20.31, are the basis for which a CBR drill is conducted. As mentioned earlier, each grouping is broken down into several specific tasks that must be performed for the successful accomplishment of the objective. For example, when attempting to set MOPP level four, the DCA must ensure the CMWD system is operating, protective masks and gloves are worn, circle william is set, and mandatory drinking water in enforced. These are required actions that must be performed for MOPP-4 to be set. An omission of a single step results in failure in meeting a training objective of the drill.

When evaluating a CBR drill, these tasks are used by training personnel as criteria for objective accomplishment. Upon completion of a drill, a detailed critique of objectives

and criteria is carried out from which specific repair party weaknesses are identified. As a result, a tailored training plan is generated after each drill to correct team deficiencies with distinct training objectives as a guideline.

2. Conduct of a CBR Drill

Drill planning, execution, and feedback require concentrated effort for the training evolution to produce more effective shipboard repair teams. There must be a core of personnel who are committed to the coordination of numerous details that must collectively simulate an environment of chaos and stress. They must document personnel actions, communicate pitfalls in response actions and they must do this in a professional manner that is conducive to learning. Shipboard training personnel are tasked with maintaining the most critical element of combat readiness: team training proficiency. The crisis reaction of personnel and the ship's overall battle performance will reflect their tenacity in quality training.

a. Damage Control Training Team

The Damage Control Training Team (DCTT) is responsible for conducting a drill. They are shipboard personnel who have demonstrated exceptional proficiency in damage control and who have attained the PQS qualification as a specific DCTT team member. They must conduct a pre-drill brief among themselves to agree upon detailed drill impositions, simulations, acceptable artificialities, and exact locations of system degradations. With their props and radio communications, they man the appropriate spaces to initiate the drill. A DCTT member will accompany select damage control team members throughout the drill. They will evaluate actions and ensure no safety violations occur. For

instance, a DCTT member will follow repair party investigators throughout the ship during the course of their investigation for surrounding damage. Likewise, a DCTT member will remain in the repair locker to track communications and observe repair team members' compliance with standard procedures. All DCTT members report to the DCTT leader who will normally remain in DCC. They follow his orders in the execution of the drill time line and the adjustment of events based upon unforseen personnel actions.

3. CBR Defense Drill

A shipboard CBR drill is manpower intensive. According to NWP 3-20.31, Surface Ship Survivability, it is mandatory that a ship go to GQ when setting MOPP-3. This publication mandates that all personnel proceed to their battle stations to man various combat systems or prepare to fight probable damage. Damage control teams and fire parties will comprise almost half the crew of a typical combatant ship. Of course, a drill may be modified to involve only the personnel who are directly impacted by the specific training objectives designed into a tailored drill. However, to rehearse all ship-wide training objectives, more drills will have to be conducted to exercise the entire crew.

In terms of damage control teams, three repair lockers must be manned during GQ. Each locker will consist of the RPL, plotter, phone talker, OSL, ATL, two hose teams, access and overhaul men, investigators, electrician, boundary men, and a corpsman. Also, DCC will be manned with approximately six people to coordinate actions with the repair lockers and make reports to the ship's CO. Additionally, a CBR scenario requires the manning of CCAs decontamination stations with internal and external survey teams and decontamination teams. Obviously, a routine CBR drill with its compliment of repair party members, CBR

defense teams and DCTT counterparts requires extensive effort by numerous crew members. Indeed, a single two-hour drill can easily consume over 250 man-hours.

IDCTT provides an alternative to the comprehensiveness of a CBR drill and is a viable option for damage control training. IDCTT does not replace full-scale shipboard drills. However, it minimizes the number of drills necessary to maintain repair party proficiency by focusing quality training on key command and control decision-makers. Repetitive IDCTT training with DCAs and RPLs should optimize the efficiency of traditional emergency drills by preparing those individuals to facilitate the smooth flow of drill events. Additionally, they will bring enhanced decision-making skills and self confidence to the drill scenario, thus displaying more empowering leadership to damage control teams.

II. METHODOLOGY

A. OVERVIEW

The following is a detailed discussion of the methodology employed in assessing the effectiveness of the shipboard IDCTT trainer. The systematic approach that is applied in this study draws from previous research conducted by Mark Johnson (1993) on the prototype version of the IDCTT trainer. In that regard, parallels may be extracted from these analyses to formulate trends in the evolution of IDCTT. Since future expansion of computer-based training is expected, historical documentation of system upgrades will aid in the continuous improvement of shipboard training technology.

This chapter describes the necessary information needed to conduct such an evaluation. Then, it explains how this information was collected. Finally, the statistical techniques that are utilized to analyze the data are outlined. Ultimately, data analysis provides a reply to the research questions that this thesis is designed to answer. They are as follows:

- When compared to conventional training methods through the use of standardized watchstander performance measures, is the IDCTT version 3.0 an effective shipboard damage control trainer? Does it save time?

- Based on crewmember interviews and surveys, are there dimensions of the IDCTT version 3.0 that should be improved?

- How will the IDCTT version 3.0 become integrated into a shipboard damage control training continuum?

- Does the IDCTT version 3.0 provide a team training approach for the DCA and RPL?

B. REQUIRED INFORMATION

In order to assess the effectiveness of a specific instructional method, various elements of the method must be measured. Once this is done, a general assessment of its effectiveness can be made based on specific criteria. However, when a new method is proposed to replace or augment some already established technique, there is an additional parameter that serves as a benchmark of training utility. By comparing the old with the new, useful information may be obtained.

For this reason, the information gathered to assess the IDCTT trainer's effectiveness focuses in two areas. First, the IDCTT trainer's performance as a stand-alone method of training for a CBR environment is examined. Then, the IDCTT trainer is compared to the conventional method of conducting traditional CBR drills. Additionally, crewmembers from USS Harpers Ferry (LSD-49) were queried about their impressions of the IDCTT trainer and the dimensions that they felt should be improved. Also, shipboard training personnel were asked to articulate their visions of the integration of IDCTT into a shipboard training program along with their impressions of its utility as a DCA/RPL team trainer.

1. IDCTT Trainer Performance Evaluation

This portion of the study utilizes survey forms to gather shipboard trainee and instructor inputs to evaluate the performance of IDCTT. The aim of the *Trainee IDCTT Survey* and the *Instructor IDCTT Survey* is to identify strengths, weaknesses, and potential improvements to the system. These surveys incorporate the use of short essay descriptions,

rating data, and check-off lists of potential problem features of the IDCTT. Appendix B contains all survey forms that were used in this study.

a. *Short Essay Descriptions*

Upon completion of several IDCTT scenarios, Harpers Ferry trainees and DCTT members were asked to complete their respective survey forms, which contained five of fourteen questions requiring a narrative response. Each of these questions focuses on a different dimension of the trainer. These dimensions are as follows:

- Problem features.
- Performance of the GUI.
- Problems encountered while using the trainer.
- Favorable aspects of the trainer.
- Unfavorable aspects of the trainer.

b. *Rating Data*

Rating data are collected through a method in which respondents assign a value to their opinion about a certain subject matter. In this case, three sources of rating data are collected from trainees and instructors. First, there are seven questions on the *Trainee/Instructor IDCTT Surveys* that are designed to asked for this type of information. Then, the *User Interface Dimension Questionnaire*, and the *Source of Workload Evaluation* are used. Respondents were asked to circle a number on an eleven-point rating scale where each end of the scale is marked with an extreme, opposing opinion of the subject matter.

c. *Check-Off List Data*

One question in the *Trainee IDCTT Survey* lists seven IDCTT system hardware and software items. Trainees were asked to check off the system features that

causes them difficulty. The following seven features are evaluated:

- Ease of operation of the GUI.
- Clarity of audio reports.
- Ability to locate D.C. diagram information.
- Acceptability of the speed or volume of information presented.
- Presentation of the damage control alarm panel display.
- Presentation and operation of firemain alarm panel.
- Other features not included in the survey list.

d. Instructor Evaluation of the System

Each member of the DCTT who participated in this study was asked to complete the *Instructor IDCTT Survey*. They were free to identify any feature of the trainer that they considered important. They were encouraged to evaluate the system's applicability as a shipboard team trainer with its possible drill scheduling and time saving impact. Similar to the *Trainee IDCTT Survey*, this survey produces rating data as well as narrative essay information.

2. IDCTT Trainer versus Conventional CBR Drill

As described earlier, a CBR defense exercise is an extremely comprehensive and demanding drill scenario. Therefore, since it is commonly practiced onboard U. S. Navy ships, it serves as an excellent standard for which to compare the IDCTT trainer. By evaluating shipboard personnel in both a CBR drill and an IDCTT scenario, a comparison can be made of various features of each, such as time to complete the training. Through the use of a standardized grading sheet, trainee performance scores are used to evaluate a multitude of instructional dimensions. Survey information is also collected here to obtain rating data that reflect the trainee overall comparison of the two training methods.

a. *Standardized Grading*

Since a conventional CBR drill and an IDCTT CBR scenario support the same overall objectives, it is argued that trainee success is primarily dependent upon the medium in which training is conducted. The development of a standardized grading system provides a means to examine trainee performance with both training methods. When this is accomplished, a determination is made about trainee performance on the IDCTT and the capability of IDCTT to reinforce vital training subject matter.

Currently, there is no quantitative means to evaluate shipboard CBR drills. NWP 3-20.31 delineates the actions that are required by the DCA and RPL to contain and control successfully the spread of chemical, biological and radiological elements. However, this is an itemized list of actions rather than a quantitative value scale. The grading criteria used in this study's standardized grading sheet were developed by assigning a relative importance to each required action for CBR defense as outlined by fleet directives. There are twenty nine line item requirements that hold a point value between two and five for a possible total of 100 points. These requirements emphasize basic damage control principles, TSS concepts, asset management, and fleet practice. The standardized drill grading sheet may be found in Appendix B.

b. *Rating Data*

Two separate surveys are used to collect rating data that compare the two training methods. The *IDCTT versus CBR Drill Survey* describes trainee comparisons of the two methods. Meanwhile, the *Scenario Topics Ranking Survey* expresses the trainees'

opinions of the level to which each training method achieves the specific damage control training objectives.

(1) *IDCTT versus CBR Drill Comparison Survey.* Trainees who were evaluated on the IDCTT trainer were asked to complete this survey form. Eleven IDCTT system characteristics were presented on a bipolar preference scale anchored on one end by the IDCTT and on the other end by the CBR drill. A six on the scale indicates "no preference" between the two methods. Trainees circled the number that corresponded to the degree they felt one method outperformed the other. The following is a listing of the eleven system characteristics:

- Created a realistic simulation of a shipboard environment.
- Enabled instructors to provide complete post-scenario debriefs.
- Produced the greatest level of stress.
- Allowed instructors to monitor trainee progress.
- Prepared the trainee for actual shipboard emergencies.
- Responded to trainee inputs more easily.
- Provided scenario information closely resembled shipboard methods.
- Provided more effective teaching environment to exercise D. C. Drills.
- Promote greater learning in the time allotted.
- Preferred training method.
- Stimulated the trainee to perform.

(2) *Scenario Topics Ranking Survey.* All trainees were requested to complete the *Scenario Topics Ranking Survey.* The survey lists a series of fundamental damage control actions needed to resolve a damage control problem. Trainees rated the extent to which they felt each fundamental topic played a role in the battle problem delivered by IDCTT and a CBR drill.

The *Scenario Topics Ranking Survey* yields two measures. First, an ordinal ranking of thirteen damage control fundamentals that each scenario emphasizes is made based on the median scale value from the ranking responses. This ranking is used to determine if the two training methods emphasize the same damage control fundamentals and to what degree. Second, the interquartile range (IQR) from each method's rating data is compared to determine how much the trainees rankings varied across the two methods. These data highlight the extent to which each system consistently emphasizes the same learning objectives from the perspective of the trainee.

C. METHODS OF DATA COLLECTION

The IDCTT version 3.0 was installed onboard USS Harpers Ferry (LSD-49) in December of 1997 in San Diego, California. Prior to the addition of this trainer, the only method of training their DCA, Duty Engineers, and RPLs for the CBR threat was with full-scale shipboard emergency drills. The execution of these comprehensive scenarios provided the only means for shipboard personnel to remain proficient in the damage control training objectives that they last experienced at a schoolhouse training facility. The installation of this trainer outfits the crew of Harpers Ferry with the most highly advanced damage control trainer in the fleet while rendering an excellent opportunity to assess its effectiveness in the actual environment it is designed to operate.

The data for this study were collected over an eight-week period from 22 December 1997 through 21 February 1998. Prior to the evaluation, Harpers Ferry's damage control

personnel had sufficient time to familiarize themselves with the operation of IDCTT version 3.0. To facilitate this research, data were collected from the crew of USS Rushmore (LSD-47) who conducted actual CBR drills. The results of these traditional chemical warfare defense exercises were then compared to the outcomes of the IDCTT CBR scenarios that were conducted onboard Harpers Ferry. Through the standardized grading system described earlier, data were collected to determine whether the IDCTT-trained group could demonstrate satisfactory performance in standard CBR test scenarios. Because Harpers Ferry personnel were measured on just the IDCTT trainer, a design limitation exists. Ideally, personnel would be assigned randomly to treatment groups, the IDCTT-trained group would be measured on an actual CBR drill and then compared to the traditionally trained group. This design would allow a comparison of the relative effectiveness of the two training methods. However, this approach was not possible due to ships' overhaul and underway schedules. Nonetheless, the data collected in this study permit an exploration of whether both groups demonstrate similar levels of understanding on the standard CBR scenario performance measures and an assessment of IDCTT's capability to reinforce these vital elements of training.

Throughout the evaluation period, representatives from Systems Integration and Research, Inc. (SIR), a privately owned engineering research and development firm based in Arlington, Virginia, played an active role in coordination and execution of shipboard exercises. They acted as the primary liaison between the author and the afloat commands

in addition to providing technical guidance to the ships throughout the computer installation process.

Toward the end of the evaluation period, opinion surveys were administered and interviews were conducted with shipboard personnel. The formal structure of the evaluation and professional nature of such a research effort injected additional pressure on trainees. It was hoped that their post-evaluation opinions would be richer with commentary after experiencing this increased level of individual scrutiny. The following sections discuss trainee assignments, survey administration, and trainee scoring criteria.

1. Trainee Assignments

Trainee groups were split between USS Harpers Ferry (LSD-49) and USS Rushmore (LSD-47). This allowed one group to be evaluated during conventional CBR drills, while the other group was subjected to the IDCTT scenarios. All shipboard personnel had equivalent schoolhouse and shipboard training experience prior to the first day of this evaluation. It is not, of course, possible with this design to eliminate any variability that may exist due to specific ship assignment.

On both ships, trainee groups contained Duty Engineers and RPLs. They were further divided into groups containing one Duty Engineer and one RPL. These groupings conducted the scheduled CBR drills and IDCTT scenarios. Onboard Rushmore, a one- hour time limit was imposed for the completion of a CBR drill regardless of the overall progress made by the trainees. Normally, a CBR drill is in the decontamination stage at this point where there is minimal stress and urgency. Conversely, the first fifteen minutes of a drill is

the most stressful phase as information is ambiguous and incomplete; this is where watchstander performance is most critical. Therefore, in the interest of time management, a one-hour cap was imposed on the drills. This limitation allowed personnel time to stow damage control equipment, critique the drill, establish training objectives for future drills, and provide feedback to trainees. In view of this compressed shipboard daily routine, this measure seemed necessary and prudent. Regardless of this constraint, a significant time savings is evident when comparing IDCTT to conventional drills. Later in this study a discussion of actual time differences supports this advantage of IDCTT when weighed against full-scale drills.

2. Survey Administration

Trainees and shipboard instructors were administered surveys that were applicable to the training method for which they were exposed. Table 7 presents the distribution of surveys to trainees and instructors based on training method. Prior to trainees and instructors completing the survey forms, directions were clearly articulated to them by the survey coordinator. Trainees were encouraged to take their time, seek clarification to questions they didn't understand, and comment on any item they felt was important but not included in the survey. The survey coordinator and training instructors remained available to clarify any misunderstandings throughout the survey administration.

Table 7: Trainee/Instructor Survey Distribution

Activity	Survey Administered
IDCTT Trainer	Trainee IDCTT Survey Scenario Topics Survey (IDCTT) Source of Workload Evaluation User Interface Dimension Questionnaire IDCTT vs CBR Drill Comparison Survey
Conventional CBR Drill	Scenario Topics Survey (CBR Drill)
Trainee Evaluation	Instructor IDCTT Survey

3. Trainee Scoring Criteria

Trainee performance is evaluated in both the CBR drill and IDCTT scenario through the use of numerically assigned grades. A trainee grade sheet is used to standardize the grading between the two methods. This grading method provides data from one group of trainees evaluated on IDCTT and the other group evaluated during the conduct of a CBR drill.

a. IDCTT Grading Protocol

In accordance with the evaluation schedule of events, a total of twelve trainees completed two IDCTT training scenarios and were assigned a quantitative grade for each exercise that reflected their level of proficiency. Instructors were in a position adjacent to the trainees throughout the course of the event where they maintained a clear view of the system monitor. This practice allowed them to observe scenario events, trainee reactions, and achievement of key milestones throughout the event. They assigned grades on a scale from 0 to 100 based on the criteria outlined on the trainee grade sheets.

b. CBR Drill Grading Protocol

All personnel evaluated in the CBR drill had previously received some degree of training for such a contingency. Therefore, they were expected to display a robust level of proficiency with this training method. Similar to the IDCTT evaluation, instructors stood adjacent to the trainees where all ambient stimulation and trainee reactions could be observed. Also, grading was conducted in an identical fashion with a standardized trainee grade sheet. A total of thirteen CBR drills were conducted for evaluating the performance of twenty six personnel.

D. METHODS OF DATA ANALYSIS

Individual trainee files were maintained throughout the course of this study. The trainees responses to the *Trainee IDCTT Survey, User Interface Dimension Questionnaire, Source of Workload Evaluation, IDCTT vs CBR Drill Comparison Survey, Scenario Ranking Topics Survey,* as well as their individual performance grades were kept in these records. The pertinent information that is extracted from these responses is as follows:

- Short essay descriptions.
- Rating data.
- Frequency data.
- Performance grades.

With this information gathered, it is used as the input to the statistical analyses employed in this study. The following is a brief discussion of the specific statistical analysis methods that are utilized.

1. Short Essay Descriptions

This information allows for an in-depth assessment and understanding of trainee opinions. Since narrative data do not facilitate statistical calculation, it is primarily used as a magnification of the ranking data, which express opinions in a numerical fashion. However, this textual information was subjected to content analysis to extract categories of similar trainee responses. This system of data organization illustrates opinion trends, which imply overall sentiment toward certain features of the IDCTT trainer.

2. Rating Data

Rating data are analyzed by a method familiar in the measurement of attitudes and opinions. The Method of Equal-Appearing Intervals (MEAIS) is a procedure that attempts to apply psychological scale methods to describe an educational value. Here, the idea underlying such measurement is the equally often noticed difference, properly defined, as a unit of measurement (Thurston, 1929). Unlike the common method of paired comparison, where a respondent is required to make n(n-1)/2 comparative judgements (e.g., twenty statements would require 190 comparative judgements), MEAIS requires each trainee to make only one comparative judgement for a given statement as it obtains scale values for a large number of statements (Edwards, 1957). Scaled rating data are taken from the trainee surveys and arranged as summary statistics in tables similar to Table 8. Each statement contained three rows. Row (f) indicates the total frequency that all trainees circled a specific response. Row (p) describes the frequency as a proportion of the total number of trainees and row (cp) is a summation of the cumulative frequency proportions. With the following

assumption, a meaningful statistical calculations is made:

If the median of a distribution of judgements for each statement is taken as the scale value of the statement, then the scale values can be found from the data arranged in the manner of Table 8 by means of the following formula:

$$S=L+((.50-\sum P_b)\div P_w)\ i,$$

Where S = the median or scale value of the statement.
L = the lower limit of the interval in which the median falls.
ΣP_b = the sum of the proportions below the interval in which the median falls.
P_w = the proportion within the interval in which the median falls.
i = the width of the interval and is assumed to be equal to 1.0 (Edwards, 1957).

Once the scale value of each rating data equation is determined, the IQR is calculated for each equation. This provides graphic illustration of the variability in distribution of trainee responses to each question. The IQR is a numeric value representing the range of numbers in which the middle 50 percent of the scale judgements falls. IQR is determined by subtracting the 25th percentile from the 75th percentile. They are calculated with the following formulas:

$$C_{25}=L+((.25-\Sigma P_b)\div P_w)\ i,$$

Where C_{25} = the 25th percentile of the statement.
L = the lower limit of the interval in which the 25th percentile falls.
ΣP_b = the sum of the proportions below the interval in which the 25th percentile falls.
P_w = the proportion within the interval in which the 25th percentile falls.
i = the width of the interval and is assumed to be equal to 1.0 (Edwards, 1957).;

$$C_{75}=L+((.75-\Sigma P_b)\div P_w)\ i,$$

Where C_{75} = the 75th percentile of the statement.

L = the lower limit of the interval in which the 75th percentile falls.

ΣP_b = the sum of the proportions below the interval in which the 75th percentile falls.

P_w = the proportion within the interval in which the 75th percentile falls.

i = the width of the interval and is assumed to be equal to 1.0 (Edwards, 1957);

$$IQR=C_{75}-C_{25}.$$

Upon completion of these calculations, the statistical data are compiled for further study.

Table 8: Sample MEAIS Data Matrix

Statement		**Sorting Categories**										
		1	2	3	4	5	6	7	8	9	10	11
1.	f	4	4	5	7	4	3	2	1	2	0	0
	p	.13	.13	.16	.22	.13	.09	.06	.03	.06	.00	.00
	cp	.13	.26	.41	.63	.75	.84	.91	.94	1.0	1.0	1.0

3. Frequency Data

Frequency data captures the percentage of trainees that agreed with the check-off list items in the *Trainee IDCTT Survey*. Recall that this check-off list of system features contains items that could possibly cause user difficulty. A summary statistic is obtained by summing the number of trainees who checked specific items, then dividing by the total number of trainees in the study.

4. Performance Grades

The Wilcoxon Signed-Rank Test for a Paired Experiment is used to analyze the performance grades to determine their relative frequencies.

To carry out the Wilcoxon Test, the differences for each of the paired scores is calculated. Differences equal to zero are eliminated. The rank of

the absolute values for each of the numbers is determined, assigning a 1 to the smallest, 2 to the next smallest and so on. The rank sum is calculated for each of the positive and negative differences. The positive value of these two calculations is used to calculate the z-value from the normal curve and is used as the test statistic. This test statistic is then compared against the z-value for the appropriate significance level desired. This comparison is used to determine if the null hypothesis, that the two frequency distributions are the same, should be accepted (Mendenhall, 1990).

The calculations in this portion of the study provide insight to the utility of IDCTT. Here, we equate the characteristics of CBR drill training to IDCTT version 3.0 and observe whether IDCTT-trained personnel demonstrate performance outcome measures similar to those obtained from the traditionally trained groups.

III. RESULTS

A. OVERVIEW

This chapter will report the results of the IDCTT version 3.0 effectiveness assessment. The methodology described in Chapter II of this thesis is employed in the summation of these results. Accordingly, all data were provided by USS Harpers Ferry (LSD-49) and USS Rushmore (LSD-47) as the inputs to this trainer evaluation. A total of fifty personnel from these two ships participated in this study between 22 December 1997 and 21 February 1998. They are considered to possess a cross-section of the average damage control aptitude levels representative of fleet personnel. After having experienced basic indoctrination training, advanced technical training, and routine shipboard training the officers and enlisted personnel onboard these ships exemplify the standard level of damage control knowledge that exists onboard all U. S. Navy ships. Since all naval personnel receive equal exposure to damage control fundamentals prior to their assignment to a ship and then fit into a shipboard training program once they have reported, the personnel involved in this study provide a fleet snapshot of damage control competency and crisis response proficiency.

The data are illustrated in two broad categories of findings. First, they are presented in relation to the IDCTT as a stand-alone training technology. Second, the results are presented as a comparison of the IDCTT's relative effectiveness when compared to

traditional methods of shipboard training. This chapter portrays only the results of this study. Chapter IV provides the reader with an analysis of the results.

B. IDCTT TRAINER PERFORMANCE EVALUATION

The data that are reflective of the IDCTT performance were collected in the form of short essay question responses, rating data, check-off problem features, and instructor evaluations. This information was extracted from surveys that were administered during the evaluation period. The following sections address the trainee and instructor responses to specific survey questions.

1. Short Essay Descriptions

The short essay descriptions are taken directly from the *Trainee IDCTT Surveys* and the *Instructor IDCTT Surveys*. This section discusses only the information from the trainee responses; the instructor responses will be discussed in a later section. There is a total of sixteen questions in the *Trainee IDCTT Survey*. Six questions require narrative descriptions while the remainder are in the form of check-off features and scale ratings. The first essay question asks trainees to identify the features of IDCTT that cause them difficulty in the operation of the system. Responses to this question are summarized in Table 9.

Table 9: Summary of Trainee Responses to IDCTT Features that Cause User Difficulty (and Number of Respondents).

Feature	Comments
Mouse and keyboard.	1. No responses.
Audio reports.	1. I was unable to ask "watchstanders" to repeat their last report. (8) 2. There was confusion between the DCA and RPL displays. (11) 3. I could not keep track of all reports. (11)
Locating ship-specific valve and compartment numbers.	1. I had difficulty locating items on the menu since they were arranged numerically, not alphabetically. (2) 2. I had difficulty locating info on D.C. plate and menus at the same time. (6)
Speed and volume of information.	1. The scenario moved too fast. (16) 2. The pace should be adjustable to need individual proficiency levels. (7)
Damage control alarms and displays.	1. There was no low firemain pressure alarm. (1) 2. The RPL did not have any CPS indications. (5)
Firemain valves and pumps operation and display.	1. This would be better as a separate display. (4)
Other.	1. I was unable to communicate directly with specific repair personnel (i.e., investigators). (9) 2. I was unable to make recommendations up the chain of command. (7) 3. Unfamiliarity made initial operation difficult. (3) 4. I was unable to request changes in the engineering plant. (2) 5. The RPL could not initiate actions without DCA permission even though he could hear the CO on the 1MC. (7)

The balance of the responses to essay questions are summarized in Table 10. They refer to IDCTT preferences, GUI issues, and shipboard training program applicability.

Table 10: Summary of Trainee Responses to Short Essay Questions (and Number of Respondents).

Question	Comments
How can the mouse, menu, keyboard, and monitor presentation be improved?	1. Larger monitor would make reading valve numbers and report chits easier. (7)
What problems did you encounter while using the IDCTT trainer?	1. I thought the time given to set zebra, MOPP levels was too short, not realistic. (17)
What aspects of the IDCTT trainer did you like the most?	1. Graphics gave a good overall view of the problem. (21) 2. The interface prompted my memory of required actions. (19) 3. The mouse was a familiar thing. It made my response real quick. (15) 4. The pace was fast and kept me thinking. (8)
What aspects of the IDCTT trainer did you like the least?	1. The engineering plant, firemain, draft report status would have been better displayed separately. (6) 2. I could not get the status of ordered actions (zebra, MOPP, etc.). (11) 3. The reasons for scenario failure were too general. (6)
How would the IDCTT trainer be integrated into your ship's damage control training program?	1. More training on an individual basis. (12) 2. Don't need to run as many drills. (20) 3. More practice by repair locker teams. (13) 4. Schedule training just for the DCA and RPLs, then they are more ready to run a full drill. (6)

2. Rating Data

Trainee rating data are drawn from the *Trainee IDCTT Survey*, the *IDCTT User Interface Dimension Survey*, and the *IDCTT Source of Workload Evaluations*. Each trainee from USS Harpers Ferry (LSD-49) who was exposed to the IDCTT was asked to respond to several questions on a scale from one to eleven. A high value on the *IDCTT User*

Interface Dimension Survey and the *IDCTT Source of Workload Evaluation* represents a positive response or a greater demand, respectively. The *Trainee IDCTT Survey* asks for information that requires a more specific measure of opinions. For example, when asked about scenario understandability, a low value refers to a confusing scenario while a high value indicates clarity. Conversely, questions about scenario realism utilize a scale where a low value refers to a realistic scenario and a high value indicated an unrealistic exercise. The scale values and interquartile ranges (IQR) from these surveys are presented in Tables 11, 12, and 13.

Table 11: Scale Values and Interquartile Ranges of Trainee Impressions of Ten IDCTT Design Aspects.

Question	Scale Value	IQR
How easy was the system to operate? (Difficult...Easy)	7.32	2.81
How much information could you input with the mouse? (All...None)	2.64	1.51
How easily could you input information with the mouse? (Difficult...Easy)	9.85	1.23
Was the scenario too difficult? (Difficult...Easy)	6.67	3.00
Was the scenario easy to understand? (Confusing...Clear)	8.35	1.92
Was the scenario pace too slow? (Fast...Slow)	2.98	2.72
Was the scenario realistic? (Realistic...Unrealistic)	2.41	1.16
Usefulness as a shipboard trainer? (Useful...Not useful)	1.21	0.45
Beneficial in damage control training program? (Beneficial...Not beneficial)	2.87	1.08
Usefulness as a team trainer? Useful...Not useful)	2.54	1.87

Table 12: Scale Values and Interquartile Ranges of Trainee Impressions of Eight IDCTT Interactive Courseware Design Aspects.

Statement	Scale Value	IQR
Ease of use? (Difficult...Easy)	9.81	1.85
Navigation? (Difficult...Easy)	9.33	2.03
Cognitive Load? (Unmanageable...Manageable)	7.28	2.47
Mapping? (None...Powerful)	9.63	1.06
Knowledge Compatibility? (Incompatible...Compatible)	9.53	2.62
Information Presentation? (Unclear...Clear)	8.83	1.55
Media Integration? (Uncoordinated...Coordinated)	9.92	1.04
Overall Functionality? (Dysfunctional...Highly Functional)	9.65	1.98

Table 13: Scale Values and Interquartile Ranges of Trainee Impressions of Six IDCTT Workload Demand Aspects.

Workload Aspect	Scale Value	IQR
Mental Demand? (Low...High)	8.92	1.83
Physical Demand? (Low...High)	2.11	0.03
Temporal Demand? (Low...High)	9.91	2.02
Performance Demand? (Low...High)	7.25	1.54
Effort Demand? (Low...High)	6.01	1.87
Frustration? (Low...High)	9.16	2.31

3. Frequency Data

Question number four of the *Trainee IDCTT Survey* presents the respondent with a list of system operations that could potentially cause difficulty in completing an IDCTT

scenario. Table 14 illustrates the number and percentage of trainees who responded by checking specific items.

Table 14: Number and Percentage of Trainees Who Expressed Difficulty in Specific IDCTT Features.

IDCTT Feature	Number of Trainees who checked each feature out of 24 trainees.	Percentage of 24 Trainees who checked each feature.
Mouse and keyboard.	0	00
Audio reports.	11	46
Locating ship-specific valve and compartment numbers.	9	37
Speed and volume of information.	13	54
Damage control alarms and displays.	4	17
Firemain valves and pumps operation and display.	7	29
Other.	12	50

4. Instructor Evaluations

Shipboard damage control training personnel were asked to respond to twelve questions on the *Instructor IDCTT Survey*. Six of these questions collected rating data from an eleven point scale, while five solicited short essay descriptions. Instructor short essay descriptions are summarized in Table 15. Also, instructor responses to rating data questions and interquartile ranges (IQR) are listed in Table 16.

Table 15: Summary of Instructor Responses to Short Essay Questions (and Number of Respondents).

Question	Comments
What aspects did you like about IDCTT for teaching damage control problems?	1. I like the idea of computerized training. (5) 2. This saves me a lot of time so I can focus on training instead of all the preparations and clean-up. (5)
What problems did you encounter while using the IDCTT as an instructional aid?	1. The computer program should prompt individuals when they make mistakes. (3) 2. I thought the expected time to set MOPP levels and Zebra was too fast. (4)
What aspects of the IDCTT would you like to see changed?	1. More scenarios. (5) 2. Vary difficulty levels. (3) 3. Display training objectives to the trainee prior to running a scenario. (5) 4. Include training tutorials about different types of drills including the primary training objectives. (5)
What benefits do you envision from the use of IDCTT onboard your ship?	1. Cross training. Junior personnel will get a chance to act as DCA/RPL. This will allow faster PQS qualification and a better understanding of all jobs in the DC organization. (5)
How would the IDCTT trainer be integrated into your ship's damage control training program?	1. This will generate interest in damage control since it is so much like a computer game. (3) 2. Quarterly refresher training to maintain proficiency. (2) 3. Require actual PQS line items for IDCTT use. (2) 4. Schedule IDCTT scenarios on a weekly basis. (3) 5. Have all DCTT train on IDCTT to become proficient on all scenarios and training objectives. (2) 6. This has great potential for cross-training. (5)

Table 16: Scale Values and Interquartile Ranges of Instructor Impressions of Five IDCTT Teaching Aspects.

Question	Scale Value	IQR
How easily did IDCTT allow you to instruct trainees? (Easy...Difficult)	2.56	1.38
How realistic was the IDCTT trainer? (Realistic...Unrealistic)	4.91	1.12
Extent you would like to see IDCTT used fleet wide? (Much...Little)	2.24	1.50
What are your trainees' reactions to IDCTT? (Positive...Negative)	2.86	2.31
How beneficial is IDCTT to you training program? (Very beneficial...Not beneficial)	3.98	2.01
How useful is IDCTT as a team trainer? (Very Usefully...Not useful)	1.98	0.78

C. IDCTT TRAINER VERSUS CONVENTIONAL CBR DRILLS

Trainees onboard USS Rushmore (LSD-47) conducted conventional CBR drills in accordance with published fleet requirements from NWP 3-20.31. Their graded drill performances are compared to trainees onboard USS Harpers Ferry (LSD-49) who worked the IDCTT with the installed CBR scenario. Additionally, Harpers Ferry personnel were asked to complete the *IDCTT vs CBR Drill Comparison Survey* and the *Scenario Ranking Topics Survey*. Here, rating data and training objective information were obtained for comparing training effectiveness between actual drills and IDCTT operation. The results of this data collection are presented below.

1. Graded Exercises

All trainees involved with this study were assigned a grade from the standard drill evaluation form for their performance in a CBR drill or IDCTT CBR scenario. These scores provide the data that are analyzed using the Wilcoxon Signed-Rank Test. This assessment disclosed an increased population relative frequency distribution of grades for the IDCTT trainer when compared to the population frequency distribution of grades for CBR drills. All data were analyzed at the .025 level of significance. Table 17 is a comparison of the summary statistics for the two methods of training. The Wilcoxon Signed-Rank Test calculations, Wilcoxon ranks, and trainee scores are located in Appendix C.

Table 17: Summary Statistics of Trainee Scores During Graded Exercises.

Statistical Parameter	CBR Drill	IDCTT
Mean	88.2	91.8
Median	87.5	89.5
Standard Deviation	5.42	4.97
Minimum Score	77	80
Maximum Score	98	99

2. Rating Data

Scale values and interquartile ranges (IQR) are calculated using information from the *IDCTT vs CBR Drill Comparison Survey*. Table 18 illustrates the comparison of these values between the IDCTT trainer and conventional CBR drills. In this survey, the rating scales range from one to eleven where one equals "IDCTT" and eleven equals "CBR Drill."

Hence, a lower value on the rating scale indicates a preference for the IDCTT trainer. Likewise, a higher numerical ranking reveals a desire for CBR drills and a value of six symbolizes a neutral opinion.

Table 18: Scale Values and Interquartile Ranges of Comparison Items Between IDCTT and CBR Drill Training.

Question	Scale Value	IQR
Realistically simulated a shipboard environment?	5.23	2.41
Provided best post-scenario debrief?	3.22	1.01
Induced greater level of stress?	8.67	2.39
Enabled greater trainee monitoring?	4.51	1.73
Prepared trainee for actual casualty?	7.68	5.21
Provided easiest means to take actions?	3.18	1.18
Provided scenario information more clearly?	4.24	3.68
Effectively taught damage control skills?	4.69	1.98
Promoted greater learning in time allocated?	1.66	0.85
Preferred method of training?	2.76	1.28
Method that inspired greater performance?	7.53	2.78

Table 19 presents the scale values and interquartile ranges (IQR) for each fundamental damage control topic. This information is extracted from the *Scenario Topics Ranking Survey*. Here, fourteen topics summarize the principle actions necessary to resolve a CBR problem. Trainees first indicate the method of training they experienced. Then, they rate the topics on a scale from one to seven. A one indicates that the topic is not emphasized,

while a seven indicates the topic is strongly emphasized. This system measures trainees' opinions of the degree a topic is emphasized in their damage control problem.

Table 19: Scale Value, Interquartile Range, and Rank Order of Fundamental Damage Control Topics Comparing IDCTT Versus CBR Drill Training.

Measure	**Scale Value** (IDCTT)	**Scale Value** (CBR-D)	**IQR** (IDCTT)	**IQR** (CBR-D)
Communications.	6.03	4.82	1.28	2.68
Inform the chain of command.	5.67	6.24	2.39	1.03
Proceed through MOPP levels.	6.11	4.31	1.01	1.21
Set GQ.	6.75	6.47	1.83	2.65
Activate CMWD.	6.81	4.28	0.67	1.12
Manage DCC.	4.81	5.41	3.12	1.25
Use of protective equip.	4.69	6.67	1.92	0.51
Manned/ready reports.	5.78	5.60	2.62	2.07
Set Circle William.	6.37	5.83	1.42	2.61
Manage personal casualties.	2.33	3.21	3.81	2.98
Location of contamination.	5.49	4.46	2.57	2.47
Prioritize casualties.	2.19	2.48	1.19	1.86
Coordinate Decon efforts.	3.21	6.85	1.69	2.26
Monitor ship for contamination.	4.16	4.57	2.24	1.23

3. Time

Each graded scenario conducted in this study was timed for comparative evaluation between the two methods of training. Table 20 depicts the actual elapsed times for completion of an IDCTT CBR scenario relative to the total time required to conduct a full-

scale CBR exercise. As noted earlier, there was a one-hour limit placed on the CBR drills. This was done purely in the interest of time management during a busy shipboard pre-deployment work-up training routine. The majority of these drills were in the decontamination phase at the one-hour mark. Therefore, relatively little training value, for purposes of this study, was lost by securing the drill. Additionally, the majority of CBR training objectives were achieved prior to drill termination.

Table 20: Scenario Time Comparisons for IDCTT Trainer versus Conventional CBR Drills.

Scenario Number	**IDCTT**	**CBR Drill**
1	11 Min.	49 Min.
2	14 Min.	52 Min.
3	16 Min.	58 Min.
4	12 Min.	47 Min.
5	21 Min.	60 Min.
6	19 Min.	60 Min.
7	17 Min.	41 Min.
8	14 Min.	53 Min.
9	12 Min.	60 Min.
10	18 Min.	45 Min.
11	17 Min.	54 Min.
12	15 Min.	60 Min.
Average Time	15.5 Min.	53.5 Min.

IV. ANALYSIS OF RESULTS

A. OVERVIEW

Naval personnel who spend tremendous amounts of time serving onboard extremely sophisticated front-line ships certainly share a vested interest in the quality of their training. Unfortunately, they normally encounter little opportunity to express their views and voice their concerns about the training content or methods for which their survival in combat may depend. They function within a system that demands total efficiency in time management where, even then, all shipboard maintenance, administration, and training requirements appear difficult to complete. As a result, training may be rescheduled, postponed or abbreviated so that perceived higher priority tasking may be accomplished. Since the returns to quality training are normally not realized until some future events dictate that personnel successfully react in a crisis environment, it becomes difficult to see the tangible necessity of adopting a radical, continuous commitment to crew exercise. Training must rise to the top of the agenda for shipboard personnel. This study provides encouraging results that suggest training is, in fact, at the forefront of concern to today's sea-going officers and enlisted personnel.

Overwhelming support for the IDCTT was voiced by personnel onboard USS Harpers Ferry (LSD-49) and USS Rushmore (LSD-47). Computer-based training technology is not foreign to any members who were interviewed or surveyed in this study. As a matter of fact, they were not only comfortable with computer operations, but also well

versed in multiple dimensions of software applications, system hardware requirements, and advanced training technologies. Every officer and sailor who was asked to express their views about the IDCTT gave a positive response. Naturally, opinions varied in regard to specific features of the trainer. However, immense enthusiasm was projected from all who benefited from the high quality training that IDCTT delivers to the shipboard environment.

With qualitative data and comparative trainee performance results compiled, one can conduct an in-depth analysis of specific features of IDCTT and determine relative utility of the trainer when weighed against the characteristics of ship-wide drills. Therefore, the initial analysis of the IDCTT examines its value as a stand-alone training device. Following that review, the IDCTT effectiveness is compared to traditional shipboard training methods. Conclusions will show that, consistent with the eagerness of naval personnel to embrace an efficient training process, the IDCTT is well received in the fleet and is a catalyst for greater commitment to readiness.

B. IDCTT TRAINER PERFORMANCE EVALUATION

From the users perspective, the most tangible element of a training evolution is seen in the manner in which the process enriches the experience. The interactivity between the trainee and the training environment offers the ingredient that fundamentally engages the learner and stimulates thought process development. By capturing and retaining the attention of the trainee, continuous thinking in pursuit of problem resolution is required. The trainee must work through a scenario with total engrossment in the immediate task while

also considering the overall damage control objectives. The IDCTT user interface attempts to capture these training qualities. The mechanism which assesses the IDCTT user interface utility is the *Trainee IDCTT Survey* and the *User Interface Dimension Survey*. The following section discusses and analyses the results that were collected with these surveys.

1. User Interface Utility

The IDCTT user interface combines graphic video of watchstander actions, audible reports of repair party members, damage control system alarms and indications, and pull-down menus for trainee action selection. As described in Chapter I of this thesis, the interface creates a realistic environment for the user and introduces the effects of time compression, interactive information flow, and real-life ambiguities. The utility of the user interface is assessed by evaluation of narrative short answer responses to survey questions and rating data that quantify opinions concerning specific IDCTT features.

a. Short Essay Descriptions

The *Trainee IDCTT Survey* asks for short answer responses to specific user interface features. The feedback concerning these elements of the trainer is insightful and constructive. For example, opinions of the actual mechanics of data entry through the use of a mouse are very positive. In light of the preference to the touch-screen monitor featured in the prototype version of IDCTT, this response is extremely encouraging. It appears that trainees prefer the mouse for physical interaction with the trainer. It is suspected that since computers are so predominant in the workplace, their presence has made computing totally familiar to everybody. In fact, none of the trainees involved in the study exercised the option

of using the keyboard when operating the trainer. Audio reports in a training scenario bring a considerable amount of stress to the trainee. While concentrating on written message reports, trainees experienced difficulty hearing what was being said to them. Some became frustrated and fell behind the sequence of events while others seemed to ignore audio reports and continued with a pre-determined plan of attack. In both cases, trainees tended to fail the drill. However, they all agreed that a greater level of information intake, via audio reports, would have helped them triumph. Upon review of their performance, most were able to locate the report that provided the key information that, when neglected, contributed to their lack of success. Certainly, greater repetition with the IDCTT will sharpen trainee listening skills thus allowing use of all information that the scenario provides. At the same time, some trainees acknowledged that an audio report was fed to them but they didn't hear all the details of the report. In this case, trainees had a strong desire to ask for the report again. Unfortunately, there was no way for them to make this request. With IDCTT, once an audible report is made, it is gone. Is this realistic? Sometimes. However, many opportunities normally arise in a real-world shipboard crisis to order a subordinate to "repeat your last" or "say again." Although this action consumes time during an emergency scenario, it is a reality. Shipboard supervisory watchstanders interact heavily with phone talkers and remote counterparts via installed communication networks.

Trainees expressed difficulty in simultaneously locating specific valve and compartment numbers on the IDCTT user interface and the ship's damage control diagrams. One respondent commented that the numerical listing of compartment numbers on a given

menu actually dampened response time; this information is more familiar by actual name. Perhaps an alphabetical listing option of valve and compartment names would be helpful. However, this request may reveal inexperience with ship-specific structural characteristics. Nevertheless, the value of this commentary is its identification of a training objective. Here, the IDCTT has facilitated further training in overall ship familiarization. Without it, trainees will not be able to complete IDCTT scenarios. More importantly though, shipboard personnel will gain greater competency in their ship's construction thus giving them the tools to fight actual damage more effectively. Obviously, correlation of compartment names and numbers should not be done for the first time during an actual emergency.

Most trainees who were exposed to the IDCTT trainer were impressed with the realism of the damage control alarms and displays. Notably, trainees commented in this area about their strong desire to observe a low firemain pressure alarm. Typically this indication is more of a concern in a fire or flooding scenario and generally pertains less to a CBR environment. Although, when MOPP level two is set and the countermeasure washdown system is activated, adequate firemain pressure is certainly needed. In fact, when MOPP level two is set, many ships require all fire pumps to be energized to ensure firemain serviced systems remain functional.[8]

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[8] The Countermeasure Washdown System (CMWDS) utilizes firefighting water to spray through numerous external nozzles to completely cover exterior surfaces of the ship with a blanket of fog. Consequently, a large volume of firemain water is needed. There are many other systems onboard ships that depend on the same firefighting water to operate correctly. For example, heat exchanges, drainage systems, and fire/flushing systems all use firemain water. Therefore, depending on the ship class and piping arrangements, it may be necessary to operate all fire pumps when the CMWDS is in use.

A critical display in the CBR environment is the collective protection system (CPS) individual zone pressure gauges. With the IDCTT version 3.0, CPS indications are seen only on the DCA interface. As indicated in Table 9, trainees stated that they would like to see that system indication on the RPL interface as well. Although this display would provide additional information to the RPL, it may not prove realistic since most ship classes do not currently provide that information in the repair lockers. Also, in many cases, the RPL exercises little control over the configuration setting of the CPS. The vent fan motor controllers that are used to set the CPS zones are typically located in Damage Control Central.

Trainees who operated the DCA console found the firemain display to be somewhat limited. This system display is accessed from a pull-down menu. Although the system diagram is presented in great detail and full color, trainees tended to forget that it was available to them. This reaction is probably a result of extensive training with the firemain system status presented on a completely separate console. Fortunately, after discussion about the advantages of this embedded display and the incorporation of the IDCTT with the Damage Control System, trainees began to see the benefits of having a display of the firemain system status at their fingertips.[9] As with many features of IDCTT, more time with this trainer should increase user familiarity and proficiency.

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[9] The Damage Control System (DCS) will be installed on all naval ships. The system uses sensors, actuators, and computer technology to configure the ship's damage control systems according to pre-determined doctrine. IDCTT will be embedded in the same computers as the DCS and allow training within the same system.

The remaining narrative responses that were extracted from the *Trainee IDCTT Surveys* focused around several communications issues. They are primarily discussed from the perspective of the RPL. For instance, on numerous occasions an RPL wanted to communicate directly to the investigators about the status of a specific compartment. Realistically, the RPL communicates with the investigators via WIFCOM radios. Although IDCTT provides a method to issue standard investigative orders over the WIFCOM, the actual order is presented in the form of a "paper" damage control message blank. This simulation left RPL trainees with the impression that they were not in close communication with the investigators. During interviews, trainees stated that they expected verbal reports back from the investigators with more detail and urgency. Consequently, trainees felt isolated from information concerning possible damage and contamination to surrounding spaces. This example illustrates the significance of investigative skills and the importance of rapid feedback to the damage control organization.

The use of the ship's 1MC announcement circuit in a damage control scenario has grown more widespread in recent years. This trend is reflected in the IDCTT graphics and video reports. Since 1MC announcements are broadcast throughout the ship, the DCA and RPL hear this information simultaneously. Throughout this evaluation, several RPL trainees would have liked to initiate emergency actions based on their understanding of the tactical situation but were not able to do so without the DCA's permission. IDCTT prevents them from taking such action by presenting a warning message to the trainee. Obviously, there are numerous reasons for strict compliance with the chain of command and RPLs generally

understand the importance of gaining permission for major system configuration changes and modifications to the ship's material condition. However, an aggressive RPL will always seek to gain the advantage over time in a crisis environment. Additionally, the IDCTT does not allow the RPL to make recommendations to the DCA regarding actions that require permission to execute. This limitation appeared in several CBR scenarios when the ship's commanding officer, communicating over the 1MC, expressed his intention to set MOPP level three throughout the ship. The RPL was constrained from taking actions within the repair zone until the DCA gave permission to set MOPP level three. Regardless of the DCA's proficiency, the flow of commands from the CO through the DCA and to repair team members ultimately equates to lost time in an environment that offers little forgiveness for delay.

Overall, the narrative data that were obtained from trainees expressed enthusiasm for the IDCTT user interface. Most comments called for expansion of the software design to facilitate even greater interactivity. Consequently, trainees wanted more alarms, displays, and the ability to communicate with the scenario.

b. Rating Data

The majority of rating data referring to the user interface is collected from trainees' responses on the *IDCTT User Interface Dimension Survey*. Figure 2 illustrates the scale values and interquartile ranges of the eight user interface aspects that focus on IDCTT interactive courseware characteristics. Relatively small interquartile ranges are present in

the different responses.[10] An example of this variability is the response to the question about the IDCTT ease of use. The scale value is 9.81 with an interquartile range equal to 1.85. This means that half of the respondents assigned a value to this question over a range of 1.85, centered on 9.81 on the rating scale. In other words, their responses spanned from 8.89 to 10.74 on the scale. On a scale from one to eleven, all respondents expressed positive opinions about the interface characteristics. For instance, ease of use (scale value = 9.81), knowledge compatibility (scale value = 9.53), and overall functionality (scale value = 9.65) all scored high on the rating scale giving the impression that trainees felt at ease with the concept of computer-based training. Also, they perceived that their particular level of knowledge about computer operations was adequate for productive use of the IDCTT. Although this finding may be a subtle, its significance is fundamental to the successful implementation of this training method. As with any form of change, there is normally a bow wave of opposition. IDCTT's acceptance by those who will use it implies long-term commitment to training with advanced, more efficient models that bring greater technology to the workplace. Without this optimistic reaction, computer-based shipboard training could suffer defeat before its complete implementation. The initial reception to this technology testified to the fact that shipboard personnel seek and accept new methods of achieving mission readiness.

[10] The interquartile range is an expression of the variability in distribution of trainee responses. It is a numeric value representing the range of numbers in which the middle 50 percent of the scale judgement falls.

Other interface rating data concentrate on aspects of the interactive courseware associated with IDCTT. In particular, navigation (scale value = 9.33), mapping (scale value = 9.63), information presentation (scale value = 8.83), and media integration (scale value = 9.92) all scored relatively high on the rating scale. These ratings indicates the users' ease and understanding of the paths that may be taken and the options available in response to scenario events. The interface aspect that scored the lowest on the rating scale is cognitive load (scale value = 7.28).[11] Although still largely considered to be manageable, this aspect is rated relatively lower than the other dimensions. This opinion may be due to inexperience in operating the IDCTT or the cognitive load may actually be significantly high. When considering long-term training effects, a heavy cognitive load will certainly challenge trainees thereby producing more capable sailors. However, as trainees gain familiarity with IDCTT it is expected that their proficiency will increase. Therefore, a large degree of embedded difficulty is desired to ensure training value persists. Coupled with the effects of DCA/RPL interactivity, the built-in cognitive load of the IDCTT trainer appears to provide a dimension of difficulty that is recognized by trainees and challenges their performance. A comprehensive look at this rating data reveals a positive acceptance of this technology for shipboard damage control training. Accordingly, trainees possess confidence and understanding of the user interface and a desire to apply its advantages to enrich their training.

[11] Cognitive load is the degree to which trainees perceive a work task to be within their ability to carry out. A high cognitive load is a reflection of the respondent's opinion that a problem is challenging yet manageable.

Results of IDCTT User Interface Dimensions Survey

	Neg. Response 1	2	3	4	5	6	7	8	9	Pos. Response 10	11
Ease of Use?										**-----X-----**	
Navigation?										**------X------**	
Cognitive Load?								**------X------**			
Mapping?										**-----X-----**	
Knowledge Compatibility?									**-------X-------**		
Information Presentation?									**-----X-----**		
Media Integration?									**---X---**		
Overall Functionality?									**----X----**		

Figure 2: Scale Values with IQRs of Trainee Impressions of Eight IDCTT Interactive Courseware Design Aspects.

2. Frequency Data

A restriction of this study is the reality of limited numbers. Conducting analysis onboard naval ships where personnel are occupied with demanding work schedules and hustling to complete requisite tasking presents a taxing assignment for the researcher. At any rate, the twenty four crewmembers who provided opinions and insights concerning IDCTT have contributed valuable feedback in the evaluation of this training technology.

Frequency data were collected in the form of percentages of respondents who expressed difficulty in one or more of the listed IDCTT check-off features. Audio reports (46 percent) and speed/volume of information (54 percent) were the primary areas of

concern for the trainees. This finding is consistent with the narrative comments regarding these features. Also, 50 percent of the respondents expressed difficulty in items not included on the check-off list. Again, this observation parallels the discussion about trainee short essay responses.

3. Scenario Critique

The scenario attribute that generated the most vigorous discussion at interviews and in survey responses focused on the pace of events. Individual opinion data were collected about the CBR scenario that is loaded on the IDCTT version 3.0. Again, this information took the form of short essay responses and rating data. Initially, trainees felt that the scenario moved extremely fast. They thought the sequence of events was overwhelming and prohibitive for productive training. However, with added familiarization and practice with IDCTT, trainees began to experience progress as they moved through scenarios with greater success. The pace did not slow, yet the training sessions became increasingly productive. In fact, the pace actually increased. As their performance improved, the interactive quality of IDCTT version 3.0 promoted a more rapid flow of scenario events. This achievement further challenged trainees and encouraged them to understand and anticipate the actions of their training counterparts. Paradoxically, the very element of IDCTT that drew critical commentary from trainees may emerge as the impetus for team-building and collective problem solving between the DCAs and RPLs. However, more data that expresses repair party performance over time, with specific measures of RPL/DCA interchange, should be

collected to determine the extent to which the IDCTT interactivity contributes to the overall team behavior.

Figure 3 represents the scale values and interquartile ranges of ten IDCTT design features including those mentioned above. Once again, the variability in responses is minimal, indicating strong consistency among individual respondent opinions. The rating data linked to IDCTT scenario characteristics, expressed on a scale from one to eleven, shows that trainees considered the events to be realistic (scale value = 2.41) and relatively understandable (scale value = 8.35). Clearly, the individuals involved in this study firmly grasped an understanding of the CBR environment since they have completed classroom instruction and conducted numerous shipboard drills. Their opinions of IDCTT's user friendly nature mirror their views of its realism and carry significant credibility based on actual CBR training experience. Their rating of the scenario pace (scale value = 2.98) agrees with their comments stating that the speed of events proceeded faster than expected. In fact, several respondents suggested incorporating varying skill levels into IDCTT. Currently, the software installed onboard Harpers Ferry's IDCTT contains a single CBR scenario. However, shipboard personnel were advised that previous versions of IDCTT are, in fact, multi-proficiency level scenarios and that upgrades to the CBR scenario are planned. Nevertheless, this comment is appreciated as it provides feedback to system designers that a demand exists for the ability of trainees to adjust the scenario difficulty level based on individual training needs.

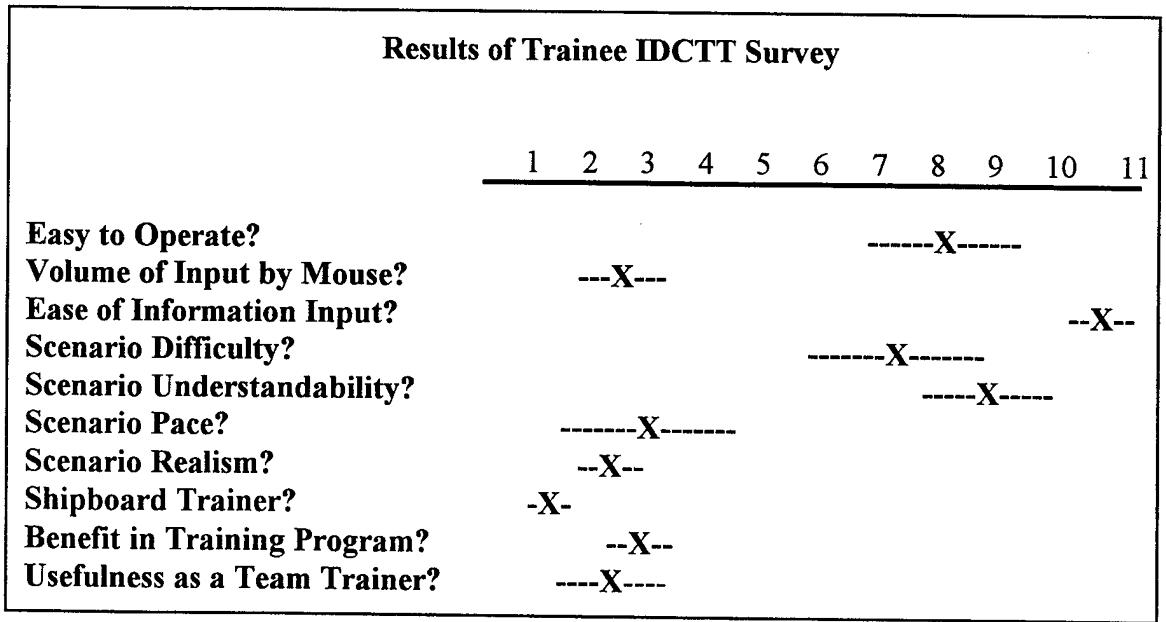

Figure 3: Scale Values with IQRs of Trainee Impressions of Ten IDCTT Design Aspects.

4. Trainee Workload

The *IDCTT Source of Workload Evaluation* emulates a technique developed by NASA to assess the relative importance of specific factors that determine the amount of workload a person experiences. Figure 4 symbolizes the relationships between the scale values and interquartile ranges of six workload-related IDCTT design aspects. Interpretation of workload levels can sometimes lead to varying conclusions. For example, some people feel that mental demand forms the essence of workload regardless of physical effort. Others feel that strong performance indicates low workload. On the other hand, some respondents have indicated that only a significant workload can yield high performance. Others feel that frustration level is the true measure of workload. In light of the assorted descriptions of

workload, the intent of the *IDCTT Source of Workload Evaluation* is to compare trainee impressions of specific demand elements that characterize their core difficulty in operating the trainer. When these challenges are determined, a parallel may be drawn between these factors and the basic notion of optimal performance under pressure. If the IDCTT is exercising a trainee's perceived high workload components, we may hypothesize that future performance will be improved.

Chapter I discussed decision-making under stress. Individual watchstanders onboard naval ships tend to experience information overload when massive amounts of data are presented to them with little time to react. The TADMUS Model was designed to overcome this limitation. Accordingly, the workload factors in the TADMUS Model include mental and temporal demands, and frustration. Consequently, the model repetitively projects these forces on the trainee. This practice develops the trainee's automatic processes for spontaneous reaction in real-world crisis. Analysis of TADMUS has concluded that large benefits have been realized through its use. Watchstanders achieve their potential for maximum performance (Dwyer, 1992). IDCTT follows this philosophy by flexing the workload factors of damage control personnel. According to the workload demand aspect rating data collected in this study, respondents expressed a high workload value for temporal demand (scale value = 9.91), mental demand (scale value = 8.92), and frustration (scale value = 9.16). These opinions of what it means to work hard and several of the IDCTT scenario design features correlate to the notion of optimal watchstander performance.

Temporal demand represents the time pressure when attempting to perform a task. Mental demand equates to thinking, deciding, calculating, and remembering, while frustration is the result of stress, irritation, and discouragement when operating the trainer. All of the psychological processes and emotions mentioned here are factors that an individual experiences when living through a crisis. Likewise, these are the key dimensions that define workload by the personnel involved in this study. The data suggest that the scenario characteristics of IDCTT are aligned with the inherent difficulties of actual crisis response at sea. Consequently, trainee performance in an actual shipboard emergency is expected to improve over time with the continuous use of IDCTT. On the other hand, physical demand (scale value = 2.11), effort demand (scale value = 6.01)), and performance demand (scale value = 7.25) all scored relatively low on the eleven point scale. As expected, physical demand, which describes motions such as pushing, pulling, and turning is minimal when operating the IDCTT trainer. Effort demand, which articulates the combined of mental and physical work, scored slightly lower than expected. This rating may be due to its relationship with IDCTT's slight physical requirements. Interestingly, performance demand scored much lower than expected. This workload dimension depicts the trainee's perceived success in accomplishing performance goals. Since the trainees were relatively unaccustomed to IDCTT, it is suspected that personnel performance standards were not established. This lack of goal setting may account for the nearly neutral rating of performance demand.

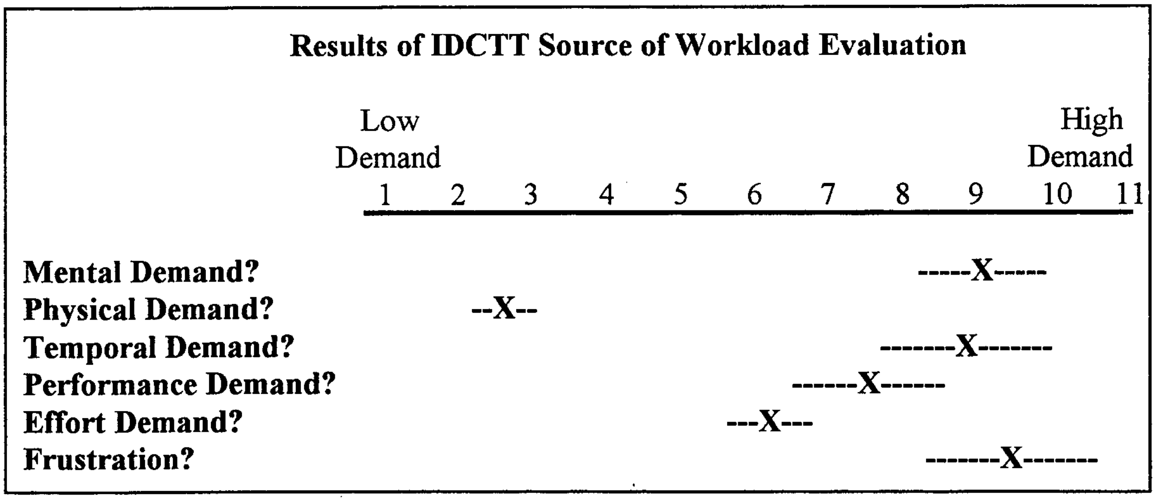

Figure 4: Scale Values and IQRs of Trainee Impressions of Six Workload Demand Aspects.

5. Instructor Evaluation

The Damage Control Training Team (DCTT) is composed of individuals who devote considerable effort in the execution of ship-wide damage control and firefighting training. Their opinions of training methods are essential in the evaluation of IDCTT and influential in its shipboard implementation. This study invites the close examination of computer-based damage control training by these experts. Their knowledge of shipboard training challenges, drill preparation and execution, and the effects of routine crew exercise attests to their value as training critics. DCTT members responded to questions on the *Instructor IDCTT Survey* that solicited short essay descriptions of their overall impressions of the IDCTT and rating data that reflected their presumptions about various instructional dimensions of the trainer.

a. Short Essay Descriptions

According to instructors, the most obvious benefit of IDCTT was its time saving-quality. From their perspective, this feature did not merely equate to greater training value in less time. Rather, it gave them the ability to spend more time focusing on learning objectives within the usual training time allocation. With virtually no time required for scenario preparation, instructors felt like the entire training evolution was saturated with learning. Many expressed the view that this advantage generated greater focus by the trainees and allowed trainers to communicate their training objectives more effectively.

Shipboard trainers claimed that IDCTT offers infinite cross-training potential and direct applicability. During the evaluation, they were anxious to challenge their most junior sailors to sit in the "hot seat" and fight the ship as the DCA/RPL. In this light, IDCTT appears to be a practical vehicle to push information and learning down the damage control chain of command to all repair party personnel. With knowledge and understanding of the command and control challenges faced by the DCA/RPL, all front-line crisis respondents will experience the pace and sequence of events that unfold during an emergency. This aspect of IDCTT strengthens its value when incorporating computer-based training technology into an existing shipboard damage control training program.

When asked specifically to comment on their vision of IDCTT as a value-adding component of their current training continuum, DCTT members quickly articulated its necessity in the PQS system. They see more rapid qualification of key decision-making personnel through required PQS signature line items that mandate the use of IDCTT. They

suggest that quarterly refresher training will be easily scheduled for DCA/RPL proficiency in addition to maintaining a high level of knowledge for DCTT personnel. Furthermore, they feel that an overall element of interest is generated in damage control training since IDCTT appeals to junior sailors with the appearance and interactivity of a video game. Shipboard trainers observed a noticeable attraction of trainees to this technology.

As with any form of assessment, all interpretation of IDCTT characteristics by shipboard trainers was not generous. They stated contravening opinions about several issues. For example, they observed an absence of a training tutorial at the beginning of the IDCTT scenario. Trainers insist that this feature would provide greater preparation to the trainee before running a scenario. They feel that an overview of basic necessary actions for crisis management should be presented to the trainee for a greater understanding of damage control training objectives. They suggest that video segments can advantageously introduce fundamental concepts just as a instructor would present an overview of forthcoming classroom discussion.

Another issue raised by instructors was their disagreement with one aspect of the IDCTT scenario. They felt that certain embedded time requirements were unrealistic. For instance, there were several occasions where trainees took action to order a change in the ship's material condition or protective posture. However, they were penalized because these actions were not completed expeditiously. Trainers thought the scenario did not allow enough time for repair party members to perform this tasking.

The only other adverse comment shipboard instructors voiced concerned scenario termination. They felt training events ended very abruptly. Several DCTT personnel would rather see the scenario prompt the trainee when making judgement errors or taking less than optimal decision paths. That way, the trainee spends more time engaged in the exercise and all phases of an emergency situation are experienced. Since the scenarios ended at a given failure point, many trainees did not gain from the latter portions of a scenario. This shortfall may be a matter of trainee experience in operating IDCTT, however, the DCTT perspective is valid since their mission is to provide the most comprehensive training possible. Normally, in the conduct of a ship-wide CBR drill every phase of the scenario, initial actions through final decontamination, is carried out. Often, the clock is advanced or actions are simulated in the interest of time management. Still, every stage of an exercise is covered.

In summary, instructors' short essay descriptions of specific dimensions of IDCTT, it is apparent that they possess a noticeable interest in training efficiency and value adding potential of the trainer. Time savings, PQS integration, and the ability to inject greater cross-training into their current training program, in their view, equates to solid benefits that bolster damage control readiness. On the contrary, their opinions of hasty scenario conclusions, unrealistic time requirements, and the necessity of training tutorials provide valuable input to software designers for future system upgrades.

b. Rating Data

The scale values of the instructor impressions of five specific IDCTT aspects,

based on an eleven-point scale, largely parallel their narrative comments. Figure 5 portrays scale values and interquartile ranges of their opinions. Narrow interquartile ranges appear in all responses. This slight variation indicates that most DCTT members expressed similar views in regard to the questions. They expressed great ease in their ability to instruct individual sailors (scale value = 2.56) on specific scenario-related damage control concepts. Also, when questioned about their observed trainee reactions to IDCTT, they relayed a positive signal about its acceptance (scale value = 2.86). Their desire to see IDCTT implemented fleet-wide (scale value = 2.24), and their opinions of its usefulness as a team trainer (scale value = 1.98) reflect a need for uniformity in damage control training between all naval ships. With IDCTT installed onboard all ships, personnel should transfer from one afloat command to another and receive greater opportunity to remain proficient in damage control skills while rapidly integrating into a new repair organization through pre-established team-building awareness. Interestingly, instructors indicated a slightly less positive quantitative response to the benefits of IDCTT as a critical element of their existing damage control training program (scale value = 3.98). There is a subtle implication in this data that was further explored in interviews with the instructors. They stated that they place great value in actual drills. Although they recognize the advantages of IDCTT, they view it as a method to prepare for higher quality ship-wide exercises. Additionally, when rating the realism of IDCTT (scale value = 4.91), instructors feel that computer-based technology brings utility to the shipboard training environment. However, they insist that a full-scale drill provides conditions that come closest to an actual casualty scenario. Overall, these

rating data express positive opinions by shipboard instructors who will play an instrumental role in its implementation.

```
                        Results of Instructor IDCTT Survey

                                 Pos.                                 Neg.
                                Response                            Response
                                 1    2    3    4    5    6    7    8    9   10   11
                                ----------------------------------------------------
Easy to Instruct?                    ---X---
Realism of IDCTT?                               ---X---
Fleet-wide Applicability?           --X--
Trainees' Reactions?                ------X------
Benefit to Training Program?              ----X----
Team Trainer Applicability?       --X--
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Figure 5: Scale Values and IQRs of Instructor Impressions of Six IDCTT Teaching Points.

C. IDCTT TRAINER VERSUS CONVENTIONAL CBR DRILLS

Trainees onboard USS Harpers Ferry (LSD-49) were well suited to compare the training value of the IDCTT trainer to conventional CBR drills. Having completed their graded evaluations, they were asked to complete the *IDCTT versus CBR Drill Comparison Survey* which compiled rating data. Based on the eleven-point opinion rating scale where one equals "IDCTT" and eleven equals "CBR Drill," Figure 6 shows that respondents preferred the IDCTT for routine shipboard training (scale value = 2.76). Upon further investigation of the trainees' approval of IDCTT, they indicated that although the trainer has

great shipboard application and time-saving features, they hesitated to rely completely on computer-based training technology for damage control readiness. This opinion is consistent with the instructors overall impressions of IDCTT's place in the damage control training program.

1. Comparative Advantages of IDCTT

Shipboard personnel acknowledged the time savings and learning effectiveness of IDCTT (scale value = 1.66). Since they appreciate the demands of post-drill clean-up, trainees noted the absence of this chore when utilizing IDCTT for shipboard training. With one hour allocated for training, one hour was actually spent learning damage control principles by running several scenarios. Also, they commented that they spent no time waiting for significant drill events to take place.[12] The trainees were entirely involved in the scenarios.

Respondents indicated that information was presented more clearly by the IDCTT (scale value = 4.24) and that it was easy to take actions during the scenarios (scale value = 3.18). This response suggests that when compared to a full-scale drill, IDCTT facilitates learning through a lucid display of events that allows the trainee to make decisions rather that become consumed in ambiguous surroundings. Once a course of action is decided, action occurs through simple computer operations. In theory, trainees are conditioned to act

[12] Many times during a ship-wide drill a specific command and control station will experience periods of inactivity. This idle time is a result of the drill focusing on action in a different area of the ship. For example, a repair locker that provides relief personnel for a specific repair team will normally wait up to thirty minutes until that action is required.

on the damage control problem rather than become overwhelmed with beleaguering and distracting occurrences that do not contribute to situation resolution. Based on observations throughout this study, it is hypothesized that IDCTT trains personnel where to concentrate so that their automatic thought processes become disciplined with a narrow focus to manage a contingency by extracting critical data from convoluted information.

Crewmembers reported their satisfaction in IDCTT's ability to provide them with real-time assessment of their performance (scale value = 3.22). Regardless of training efficiency, without this critical feedback training cannot be effective. Many times, there is a significant time-lag from drill termination to trainees receiving a critique of training objective accomplishment. Sometimes this information is not presented to damage control personnel prior to the next training exercise. Consequently, learning is not maximized and trainees repeat previous mistakes. The IDCTT eliminates this training deficiency by immediately providing the trainee with a written evaluation of their performance. Relatively neutral opinions were received when asking about shipboard environment simulation (scale value = 5.23), trainee monitoring (scale value = 4.51), teaching ability (scale value = 4.69), and performance inspiration (scale value = 7.53). The reason for this is unknown. Perhaps the survey questions were ambiguous to some respondents or they are indifferent to the subject matter. It is important to note the relatively large interquartile ranges for trainee preparation (IQR = 5.21) and information presentation (IQR = 3.68). Although the scale values give an indication of the overall opinions to these questions, the existence of a wide variability suggest that the consensus regarding these questions is not strong. The reason for

this disparity is ambiguous and may be resolved only with further individual questioning of Harpers Ferry's research participants. Nonetheless, their views of IDCTT concentrated on the facilitation of effective learning. Efficient information presentation with timely feedback appears to be a concern that influences trainee enthusiasm toward training.

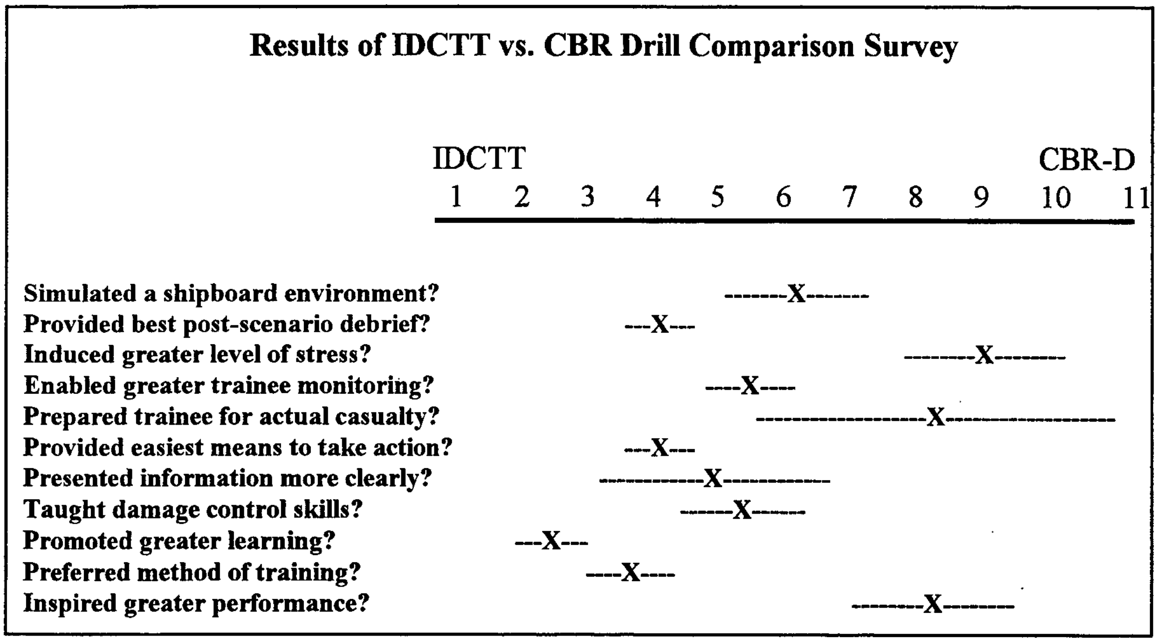

Figure 6: Scale Values and IQRs of Comparison Items between IDCTT and CBR Drills.

2. Favorable Characteristics of Ship-Wide Drills

Although IDCTT presents numerous advantages, trainees feel that there is no greater source of stress or means to prepare for an actual casualty than conducting ship-wide drills. When asked which training method induces greater stress (scale value = 8.67) and provides greater overall preparation for actual casualties (scale value = 7.68), respondents placed great value on full-scale training exercises. Nevertheless, when discussing their comparative notions, trainees preferred IDCTT over ship-wide drills as a form of quality damage control

training with significant time savings to lay the groundwork for more effective drills. They stated during interviews that greater DCA/RPL proficiency would radically increase the merit of a typical drill and amplify its benefits for all crewmembers.

3. Damage Control Topics Comparison

The intent of this portion of the study is to determine the degree to which the content of a training exercise varies between the IDCTT and conventional CBR drills. The training value of a ship-wide exercise depends on the DCTT's ability to impose realistic indications of damage thereby stimulating the thoughts and actions of the trainees. An effective damage control training team will align their drill impositions with desired training objectives to exercise a repair team's known deficiencies. Steady improvement should result when crewmembers are required to work through problems and take appropriate actions in training areas that demand rectification. Similarly, the goal of IDCTT is to manifest these damage control fundamentals in the form of computer-based interactivity between the trainees and the system software. Accordingly, IDCTT attempts to standardize the drill content and to ensure that necessary training topics are highlighted in every scenario. The *Scenario Topics Ranking Survey* that was completed by Harpers Ferry personnel provides insight to the trainees' perceptions of the presence of these underlying themes. This survey describes fourteen topics that summarize the principal actions necessary to resolve a CBR problem. Trainees indicated the training method that they experienced, then rated these topics on a scale from one to seven. A one indicates that the topic is not emphasized, while a seven indicates that the topic is strongly emphasized. This scale rating system provides a

measurement of the trainees' opinions of the degree a topic is emphasized in their damage control problem.

Of the fundamental topics on the survey, trainees consistently reported that most of these ideas are incorporated in both training methods. However, three topics were predominant in the IDCTT scenarios. Specifically, communications (scale value = 6.03), advancement through MOPP levels (scale value = 6.11), and activation of the countermeasure washdown system (scale vale = 6.81) had greater emphasis in the IDCTT scenario. The reason for this response is not totally clear but suspected to be a result of the hands-on nature of IDCTT. In order for trainees to proceed through a scenario, they must take specific actions. Without communicating effectively and physically acting to achieve casualty control measure, the scenario will end. The necessity for action here forces the damage control fundamentals to be emphasized to the trainee.

Conversely, the use of personnel protective equipment received a notably higher rating (scale value = 6.67) for the CBR drills than for the IDCTT scenarios. In an actual drill, trainees don protective equipment. Obviously, this action emphasizes the fundamental importance of this gear. Therefore, since this requirement is not inherent to the operation of the IDCTT, trainees may gain less appreciation for this fundamental training topic. Based on trainee opinion surveys regarding IDCTT scenario and CBR drill content it seems that both methods emphasize the fundamental concepts of damage control. However, the IDCTT stresses communication skills and specific task accomplishment

throughout the scenario while actual CBR drills affirm the importance of subjects relating to protective equipment use.

4. Time Advantage

Throughout this study, the durations of IDCTT scenarios and CBR drills were measured to determine the average time requirements for completing each method of training. Clearly, the IDCTT represents less demand for limited onboard training time. The average IDCTT scenario throughout the course of this study was 15.5 minutes compared to the 53.5 minutes requires, on average, for a full-scale CBR drill. These data drew praise from trainees and instructors alike. Shipboard instructors in particular applauded this IDCTT quality since it allows them to focus all interaction with the trainees toward damage control specific conversation. They note the ability to conduct more training in the usual time allocation. However, they highlight the possibility of providing training instruction within limited circumstances and opportunistic occasions.

5. Trainee Performance Evaluation

As discussed earlier in this thesis, a standardized method for evaluating trainee performance was devised. In order to analyze the actions between trainees who operate the IDCTT and those who conducted ship-wide drills, this system allows for objective trainee assessment for both training techniques. Assuming both methods display a normal frequency distribution of performance grades, calculating a test statistic, and comparing that value to a value associated with a desired level of significance a conclusion may be made regarding the distribution of evaluation grades. The Wilcoxon Signed-Rank Test is used to

determine whether the relative frequency distribution of the trainees' performance scores differs between the two training approaches. This test provides a assessment of trainee performance based on the method of training that was exercised. Unfortunately, a moderate number of respondents were available in this study. Therefore, a limitation in this method is its relatively small sample size. Subsequently, fifty individuals were graded in either an IDCTT scenario or a CBR drill. Table 21 summarizes the results of this test and a complete listing of calculations and tables for the Wilcoxon Signed-Rank Test are included are Appendix C.

Table 21: Results of Wilcoxon Signed-Rank Test.

Null Hypothesis: H_0 The population relative frequency distribution for the IDCTT trainer performance scores and traditional CBR drills performance scores are identical.

Alternative Hypothesis: H_1 : The population relative frequency distribution of the IDCTT trainer performance scores are greater than the CBR drill performance scores.

Test Statistic: $z = 2.86$

$$z = \frac{W-(n(n+1)/4)}{[n(n+1)(2n+1)/24]^{1/2}}$$

Rejection Region: Reject H_0 if $z \geq z_\alpha$

$z = 2.86$

$z_\alpha = 1.96$ at the .025 significance level.

Conclusion: Reject the null hypothesis at the .025 significance level. The distribution of performance scores for the IDCTT trainer is higher than the distribution of performance scores for traditional CBR drills.

The results of the Wilcoxon Signed-Rank Test have shown that the frequency distribution of IDCTT scores is higher than the frequency distribution of CBR drill scores.

While the performance of this group on actual drills remains unknown, these data further reinforce the potential value of IDCTT for increasing the effectiveness and efficiency of onboard damage control training. The data compliment other data reported here in which trainees clearly stated their ideas about its ability to enhance learning and challenge their thinking skills. In theory, IDCTT may be a good stress management training tool. As observed during this study, personnel who operated the IDCTT tended to concentrate harder on a scenario. They simply had no time to relax. Furthermore, the total employment of the trainee while engrossed in an IDCTT scenario seemed to generate a greater sense of responsibility for problem solving. It is suspected that DCAs and RPLs assumed the burden for success since there is a one-on-one relationship between trainees and the computer. Any failure could be viewed as a total reflection of their individual performance. This form of pressure appeared to empower trainees.

6. Summary

The IDCTT version 3.0 has been evaluated through administration of opinion surveys and statistical calculation. Crewmembers onboard USS Harpers Ferry (LSD-49) operated the trainer and provided both qualitative and quantitative feedback expressing their views of the IDCTT's applicability and value as a part of their damage control training program. The perspectives of trainees and shipboard instructors were used in the analysis of IDCTT as a stand-alone training device. There is general agreement between these two groups that IDCTT adds efficiency in management of training time and effectiveness in the communication of training objectives to repair team members.

A comparison was made between the performance of damage control team members who operated the IDCTT to those who participated in conventional CBR drills. Personnel onboard USS Rushmore (LSD-47) provided performance data from the results of actual drills. This information was compared to the performance data gained from trainees operating the IDCTT onboard Harpers Ferry. Although a direct relationship cannot be made between the trainee results onboard Rusmore to those onboard Harpers Ferry, the Wilcoxon Signed-Rank Test does suggest that trainees perform well when operating the trainer. However, further evaluation should include random assignment of trainees to groups and comparison of both groups on actual drills.

Based on the observations in this study, a strong demanded exists for IDCTT's value adding features in today's high-tempo shipboard environment. Coupled with the effects of minimal manning, training time limitations, and ship systems complexity, the IDCTT version 3.0 stands out as an effective and necessary method of providing continuous damage control training to shipboard personnel in the U.S. Navy.

V. CONCLUSIONS AND RECOMMENDATIONS

A. RESEARCH QUESTIONS REVISITED

The findings in this research lead back to a discussion of the questions that were asked prior to the initiation of the study. The first question considered the efficacy of the IDCTT version 3.0 as a shipboard damage control trainer. We have seen through detailed analysis and comparison that the shipboard version of IDCTT has the potential to provide an effective damage control training system. Trainees' and instructors' opinions of the IDCTT are overwhelmingly positive and imply that this trainer may have great utility onboard U.S. Navy ships. Further, when the Wilcoxon Signed-Rank Test is applied to trainee performance evaluations the IDCTT appears to elicit strong performance by shipboard personnel.

Although shipboard trainees and instructors acknowledge the necessity for full-scale drills in preparation for actual crisis, they see the IDCTT as a means of facilitating more productive ship-wide exercises. It is important to note the distinction between total reliance on IDCTT and the value of running drills where the effects of fatigue, physical challenge, and team reliance are demonstrated. The IDCTT does not take the place of these grueling and time-consuming training periods. However, it is perceived that continuous use of the IDCTT will better prepare damage control personnel so that training periods are used more productively.

A key benefit of interactive courseware is its ability to capture the attention of the trainee and continuously interact with the decision-making cycle of the user and mimic a tutor-student relationship. Theoretically, IDCTT challenges the thinking skills of the DCA and the RPL so that they bring enhanced intellectual skills to their ship's damage control training program. Repetitive exercise with IDCTT should prepare them to control the events in an actual drill more effectively.

The reality of limited training time onboard naval ships brings us to the next research question: Does the IDCTT version 3.0 save time? Based on the difference in duration between CBR drills and IDCTT scenarios observed in this study, the IDCTT requires less time. The average length of an IDCTT scenario is 15.5 minutes while a CBR drill takes an average of 53.5 minutes to complete. With fewer hours and personnel available to conduct training onboard tomorrow's minimally manned ships, valuable training may be accomplished in less time with IDCTT. However, this study does not specify a measurable quantity of value that is added by the IDCTT within a training scenario as compared to the value added by a CBR drill. This absence is a design limitation of the study. More research is needed in this area to determine the exact value unit per time that is associated with each training method. Then, a comparison may be made to determine the more efficient technique.

Since computer-based technologies continue to improve the quality of training, it is natural to consider dimensions of the technology itself subject to improvement. This proposal addresses the third research question: Are there dimensions of the IDCTT version

3.0 that should be improved? Survey respondents gave opinions of IDCTT features that caused them difficulty, which pinpoints them as candidates for system upgrades.

Surprisingly, trainees felt that improvements to IDCTT should be made in relation to the system's interactivity. Specifically, they would like more video interaction with the trainer when coordinating actions at the repair team level. Trainees wanted to communicate to the computer through a voice-activated type of interface. They envisioned the ability to communicate verbally with video images, such as the investigators, and receive updated reports in response. This desire suggests a request for some form of virtual reality. Indeed, that technology exists and there seems to be a demand for some derivation of training in a virtual environment onboard naval ships. When imagining the realism of such technologies, the possibilities of virtual damage control training onboard ships are endless.

Shipboard instructors also expressed opinions about where improvements to the IDCTT could be made. As discussed in Chapter IV, they are concerned about the abruptness of scenario termination and questions regarding the embedded time requirements for repair team actions. Additionally, they see a need for scenario introductory tutorials that review the overall damage control training objectives involved in the upcoming exercise.

Instructors provided the majority of the input to the final two research questions: How should IDCTT be integrated into your current damage control training continuum and how useful it is as a team trainer? They see a smooth integration of the IDCTT into the Personnel Qualification Standard (PQS) program; this system establishes the minimum required knowledge for shipboard watchstanders. Presently, damage control PQS requires

trainees to obtain signatures by qualified personnel after demonstrating knowledge of fundamental concepts and systems, then putting these ideas into practice during drills. Many times, final qualification is tied to the execution of several drills since the individual must perform as a watchstander under instruction to fulfill PQS requirements. This requirement sometimes delays qualification. IDCTT could provide a means to exercise trainees in numerous scenarios, thus requiring fewer demonstrations during full-scale drills. This advantage will expedite the qualification process.

Instructors also see great value in IDCTT's ability to provide refresher training to all damage control personnel regardless of the ship's schedule. Also, they see it as the impetus to a greater commitment to DCTT proficiency training. Consequently, the overall level of knowledge and professionalism of the ship's damage control training program will increase.

When discussing IDCTT's usefulness as a team trainer, shipboard instructors insist that it has great cross-training value. They consider cross-training to be a vital element in a team training philosophy and regard its awareness-effects to be a fundamental value in forming a cohesive damage control team. When junior personnel are challenged to play the part of RPL and DCA, they gain a deep understanding of the responsibilities associated with these assignments. As a result, they become greater contributors to the overall damage control effort and anticipate events with a better understanding of the overall objectives. Obviously, the IDCTT version 3.0 demonstrates great interactivity and team-building between the RPL and DCA. However, this finding of cross-training potential opens the door

to an entirely new approach in repair team training. With continuous use by all repair locker members, repair team quality and proficiency will reach new heights.

B. FUTURE SHIPBOARD APPLICATION OF IDCTT

The data collected in this study suggest that IDCTT will enhance shipboard damage control training effectiveness as a compliment to traditional training. Therefore, continuation of the on-going implementation of IDCTT to all afloat commands is recommended. However, there are several technical issues that must be resolved to facilitate the reliable use of this system. Based on observations onboard USS Harpers Ferry (LSD-47), the software installation process is relatively complex. In fact, the process involves a considerable amount of "software troubleshooting" in order to achieve system operation. The Systems Integration and Research, Inc. (SIR) representative who conducted the installation and who possessed extensive knowledge and training in this area still considered this task to be challenging. Even with the required skills, it took approximately one week for this specialist to get the system running.

The first recommendation that comes from this study is to implement software-related troubleshooting training for active duty personnel who will be working with computer-based training technologies. Without these skills onboard, IDCTT utilization could easily stall when the system experiences a software-related malfunction.

Since IDCTT operates on commercial-off-the-shelf (COTS) equipment, there is a natural concern that parts availability and logistical support may become critical issues.

When IDCTT was installed onboard Harpers Ferry, several network-related hardware items were unexpectedly required. These parts were purchased locally by SIR with no shipping delays. However, personal computer parts are not included in the ship's onboard stock. Obtaining these parts while deployed may result in significant delays that affect the execution of training. Therefore, the second recommendation of this study is to ensure that the naval supply system is outfitted with all hardware and software items that are associated with computer-based training technologies including technical manuals and stock number cross-references. Any deficiency in logistical readiness could hinder productive IDCTT training.

The final recommendation calls for high-level involvement that inspires a commitment to training improvement. If the IDCTT is going to be utilized effectively onboard U.S. Navy ships, there must be a designated person onboard who champions integrated computer-based training technology. Without an influential person who is billeted to manage information systems and believes in its ability to revolutionize training, the IDCTT could fade away into the background as a passing fancy. Although this research project was enthusiastically supported by two fine ships of the U.S. Pacific Fleet that provide encouraging results and demonstrate a strong desire for computer-based training, they are incredibly busy people with overwhelming priorities. This reality is an opportunity for a champion to emerge and focus the crew on training. There is no doubt that preparing a ship for deployment is a demanding undertaking that requires attention to detail in personnel issues, logistical matters, materiel concerns, and operational planning. IDCTT has the

potential to optimize training time onboard naval ships. The interactive courseware associated with this trainer introduces learning effectiveness and maximizes repair party proficiency in a shipboard environment. When supported with personnel training pipelines, logistics channels, and inspiring leadership, IDCTT can play a major role in overall damage control readiness in the United States Navy.

APPENDIX A: IDCTT TEACHING POINTS

A. OVERALL TEACHING POINTS

Report Repair Locker Manned and Ready: The Manned and Ready report signifies that personnel are available to combat casualties and are prepared with proper equipment, personal protection and communications. It is imperative that the senior person in the Repair Station provide the report to Damage Control Central as soon as personnel are ready to commence fighting the casualty. Manned and Ready time requirements are contained in FXP-4 exercise MOB-D-3-SF.

Set Zebra: Material Condition Zebra provides the greatest degree of subdivision and watertight integrity of the ship. It is the maximum state of readiness.

Set Modified Zebra: Certain situations require the CO to order material condition Modified Zebra set. Modified material condition Zebra will give a higher survivability stance than Condition Yoke, while Modified Zebra is less restrictive and will allow the accomplishment of certain operational requirements.

Change Material Condition: Changes in the ships material condition require Commanding Officer approval.

Investigate for Damage: Investigation teams should be rapidly dispatched. Any delays in investigating damage may result in the further progressive spread of damage. Investigation shall be thorough, conducted with caution, clearly and quickly reported and investigation should be repeated.

Set Flooding Boundaries: The setting of flooding boundaries should be an immediate action when flooding is reported to limit progressive flooding into adjacent compartments. Flooding boundaries should be set at the main traverse watertight bulkheads closest to the flooding.

Isolate the Firemain: Rapid firemain valve isolation will reduce flooding from ruptured piping. Firemain isolation should be coordinated with Damage Control Central to prevent disruption of vital systems served by the firemain.

Patch Holes in Bulkheads: Failure to patch a hole in the bulkhead will result in progressive flooding into adjacent compartments.

Shore Bulkheads: Failure to shore a panting bulkhead may result in the loss of the bulkhead and damage to the adjacent compartments. Indications of the need for shoring include deep bulges in plating, bowed frames and stanchions, loose rivets, cracked seems, and panting bulkheads. Panting is a dangerous condition. It results in medal fatigue which eventually causes cracking and splitting. When in doubt always shore.

Request Additional Personnel for Flooding: Requests for additional personnel should be coordinated via Damage Control Central. A failure to keep Damage Control Central informed may result in repair teams being overwhelmed by cascading casualties.

Request Transiting Routes: Routing of personnel transiting the Repair Station area should be coordinated with Damage Control Central to preserve the ships readiness posture.

Identify Critical Stability: The basic thumb rules of critical stability are contained in CNSL/CNSP Repair Party Manual. All Damage Control Assistants and Repair Party Leaders should be familiar with basic stability concepts. In some circumstances, particularly when inport, an RPL may be the only person onboard with training in stability principles. Stability may be critical if any of the following conditions exist following damage:

-Small or negative metacentric height.
-Exceeding floodable length.
-Excessive list.
-Heavy winds and seas.

Small or Negative Metacentric Height: When stability is critical due to small or negative metacentric height:

a) The ship has a slow erratic roll period and a tendency to hang at the end of the roll.
b) The ship has a tendency to list at the same angle on either side.
c) The ship has a list that cannot be accounted for by off-center weight.

Exceeding Floodable Length: When stability is critical due to excessive list, the ship lists to a static heel of 15 degrees or more.

Heavy Winds and Seas: When stability is critical due to heavy winds and seas, heavy winds and rough seas are prevailing or are anticipated.

Counterflood or Deballast: Counterflooding or deballasting require the Commanding Officers approval.

Jettison: Jettisoning requires the Commanding Officers approval.

Start/Stop Fire Pumps: Firemain management requires close coordination with Damage Central. The starting and stopping of fire pumps should be ordered by Damage Control Central.

B. FIRE SCENARIO TEACHING POINTS

Set Fire Boundaries: Any physical barrier can be a fire boundary. Ideally, fire boundaries are the bulkheads, deck, and overhead surrounding the fire. Secondary boundaries are generally set at watertight subdivisions or airtight boundaries.

Set Smoke Boundaries: Smoke boundaries are set to contain smoke within a fixed area to prevent the spread of smoke either horizontally or vertically.

Request Additional Personnel for Firefighting: Rapidly manning fire teams may be difficult if other damage control procedures are already in progress and repair personnel have been assigned to other teams. Emerging fire team requirements should be coordinated with Damage Control Central to ensure the fastest response and prevent fires from rapidly spreading.

Electrically Isolate: The extent of compartment electrical isolation and the securing of lighting is typically determined by the On Scene Leader.

Mechanically Isolate: When a space is abandoned due to fire, the space should be mechanically and electrically isolated to the greatest extent possible. A Commanding Officer may choose not to isolate such spaces if they are essential to safety, mobility, or fighting capability of the ship.

Secure Ventilation: The decision to secure ventilation systems is made on the scene.

Activate Magazine Sprinklers: Activation of magazine sprinklers requires the approval of the Commanding Officer.

Move Ammunition: The movement of ammunition onboard the ship requires approval of the Commanding Officer. Ammunition movement should be conducted by trained Combat Systems personnel and should be coordinated via Damage Control Central and Combat Systems Maintenance Central.

Activate Halon: Halon activation may prove ineffective if the compartment has been sufficiently damaged to prevent Halon from reaching the proper concentration in the space to extinguish the fire.

Evacuate Repair Locker: The evacuation of personnel within the Repair Station area to the weatherdecks may be required when smoke boundaries are not correctly ordered and set.

Directly Attack the Fire: In a direct fire attack, firefighters advance into the immediate fire area and apply the extinguishing agent directly onto the seat of the fire.

Indirectly Attack the Fire: An indirect attack is the application of water fog into the fire space through an existing access or through a hole cut into the bulkhead or overheads when heat or other conditions deny access to the space. An indirect attack may improve conditions to permit reentry for a direct attack.

Actively Desmoke: Active desmoking is removing smoke and heat from the smoke control zone prior to extinguishing the fire to aid firefighting efforts and reduce smoke spread throughout the ship.

Overhaul the Fire: Overhaul of a fire is an examination and cleanup operation. It includes finding and extinguishing hidden fires and determining whether the fire has extended to other areas of the ship.

Desmoke: After a compartment fie has been extinguished, combustible gasses may be present. The goal of desmoking is to replace 95% of the smoke laden air with fresh air. This will require approximately 4 complete space volume changes in the compartment.

Conduct Atmospheric Testing: All spaces should be desmoked before atmospheric testing is started because oxygen sensors do not operate reliably if the sensor is exposed to excessive moisture or is in contact with post-fire atmospheric particulates.

C. CBR SCENARIO TEACHING POINTS

1. Conduct operational test of chemical alarm utilizing alarm switch and installed CBR detectors.

2. Report completion of each MOPP level setting to the Commanding Officer.

3. Utilize 1MC to allow all personnel to receive information in areas outside the repair lockers.

4. Inform all personnel as to location(s) of Contamination Control Area(s) and Casualty Collection Station(s).

5. Energize all fire pumps prior to activation the Counter Measure Washdown System.

6. Utilize 1MC to inform personnel as to what MOPP level the ship is currently commencing.

7. Utilize numbering system in CBR Bill to keep all stations informed as to what step in the CBR Bill is currently being conducted.

8. Utilize NSTM 470 Appendix A to determine stay time of contamination without any actions being conducted based on current weather conditions.

9. Ensure all reports are received prior to commencing next step in the CBR Bill.

10. Keep Commanding Officer advised of all situations occurring during the CBR attack.

APPENDIX B: SURVEY FORMS

Trainee IDCTT Survey

Name ______________________________ Date ______________________________

Rank ______________________________ Years of Service ________________

Previous ships? ______________________ Time onboard? ________________

______________________ ________________

______________________ ________________

______________________ ________________

Have you served as a DCA/Duty Engineer for 6 months or more **(Circle one)**?

YES NO NA

Have you served as repair II, III, or V locker leader for 6 months or more **(Circle one)**?

YES NO NA

Your answers to the following questions will help improve the quality of shipboard damage control training you receive. Please answer the following questions **completely**, explaining your answers **thoroughly**. Use the back of the questionnaire if additional answer space is required. Upon completion, please return this survey to LT Coughlin.

---

1. Approximately how much time did you spend using IDCTT?

________ hours.

2. Have you used interactive courseware such as the IDCTT before (Circle one)?

YES NO

If yes, what courseware did you use? (use the back of this form if necessary)

3. Rate how difficult or easy the IDCTT system was to operate.

Very Difficult					Neutral					Very Easy
1	2	3	4	5	6	7	8	9	10	11

4. Check any of the following operations which caused you difficulty while operation the IDCTT system.

____ Inputting information with the mouse/keyboard.

____ Understanding audio reports.

____ Finding D.C. plate information with the Damage Control System (DCS). For example, finding compartment numbers, valve numbers etc.

____ Speed or volume of information presented. Did you easily lose track of the situation due to the speed or volume of information flow?

____ Damage control alarm panel display.

____ Firemain panel and firemain valve/pump operations.

____ Other (please specify):

5. In the space provided below, please explain why the items you checked caused you difficulty.

6. Rate the extent to which the mouse allowed you to input the information necessary to combat the damage control scenario. (Were there tasks that you wanted to do but had no way of doing them?)

All of the Information					Neutral					None of the Information
1	2	3	4	5	6	7	8	9	10	11

7. Rate how easily the mouse allowed you to input information.

Very Difficult					**Neutral**					**Very Easily**
1	2	3	4	5	6	7	8	9	10	11

8. How can the mouse, menus, keyboard, or monitor presentation be improved?

9. Rate the IDCTT scenario according to the following criteria (NOTE: This question refers to the battle problem itself and not the IDCTT system as a whole).

Too Easy					**Neutral**					**Too Difficult**
1	2	3	4	5	6	7	8	9	10	11

Very Confusing					**Neutral**					**Very Easy to Understand**
1	2	3	4	5	6	7	8	9	10	11

Too Fast					**Neutral**					**Too Slow**
1	2	3	4	5	6	7	8	9	10	11

Very Realistic					**Neutral**					**Very Unrealistic**
1	2	3	4	5	6	7	8	9	10	11

10. What problems did you encounter while using the IDCTT trainer?

11. What aspects of the IDCTT trainer did you like the most?

12. What aspects of the IDCTT trainer did you like the least?

13. Rate how useful the IDCTT trainer is as a simulation training aid for DCAs, Duty Engineers, and RPLs on your ship.

Very Useful					**Neutral**					**Not Useful**
1	2	3	4	5	6	7	8	9	10	11

14. Rate how beneficial the IDCTT trainer would be as an integral component of your ship's damage control training program.

Very Beneficial					**Neutral**					**Not Beneficial**	
1	2	3	4	5	6	7	8	9	10	1	1

15. How would the IDCTT trainer be integrated into you ship's damage control training program?

16. Rate how useful the IDCTT trainer is as a team training aid for DCA, Duty Engineers, and Repair Party Leaders.

Very Useful					**Neutral**					**Not Useful**	
1	2	3	4	5	6	7	8	9	10	1	1

Instructor IDCTT Survey

Name ______________________________
Date ______________________________
Rank ______________________________ Years of Service ________________

How long have you been an instructor (DCTT or ATG?____________________

Your response to the following items will help modify the IDCTT program to address fleet damage control training goals more specifically. This survey is designed to assess how instructors rate different aspects of the IDCTT Trainer effectiveness. There are also short answer questions where you may express your opinion of the system. Please answer all the questions **completely**, explaining your answers **thoroughly**. Use the back of the questionnaire if additional answer space is necessary.

---

1. Approximately how many hours did you spend assisting trainees with the IDCTT Trainer?

_______ hours.

2. From the instructor's perspective, rate how easily the IDCTT Trainer allowed you to instruct trainees.

	Very Easy					**Neutral**				**Very Difficult**
1	2	3	4	5	6	7	8	9	10	11

3. Rate how realistic the IDCTT Trainer depicts damage control training compared to actual shipboard damage control drills.

	Very Realistic					**Neutral**				**Very Artificial**
1	2	3	4	5	6	7	8	9	10	11

4. Rate the extent to which you would like to see the IDCTT trainer used as a fleet-wide component of a ship's damage control training program.

	Very Much					**Neutral**				**Very Little**
1	2	3	4	5	6	7	8	9	10	11

5. Rate the trainee reactions (positive or negative) to the IDCTT Trainer as an instructional aid.

	Very Positive					**Neutral**				**Very Negative**
1	2	3	4	5	6	7	8	9	10	11

6. Rate how beneficial the IDCTT Trainer would be as an integral component of your ship's damage control training program.

	Very Beneficial					**Neutral**				**Not Beneficial**
1	2	3	4	5	6	7	8	9	10	11

7. What aspects did you like about the IDCTT for teaching damage control problems?

8. What problems did you encounter while using the IDCTT as an instructional aid?

9. What aspects of the IDCTT would you like to see changed?

10. What benefits do you envision from the use if IDCTT onboard your ship?

11. How would the IDCTT trainer be integrated into you ship's damage control training program?

12. Rate how useful the IDCTT trainer is as a team training aid for the DCA, Duty Engineers and Repair Party Leader?

Very Useful					**Neutral**					**Not Useful**
1	2	3	4	5	6	7	8	9	10	11

IDCTT vs CBR Drill Comparison Survey

Name ____________________ Date ____________________

Rank ____________________

Your answers to the following questions will help improve the training you receive in shipboard damage control training. This survey will provide information for comparing the effectiveness of the IDCTT Trainer and CBR Drills as training methods. This survey is designed to determine your opinion on the ability of the IDCTT and CBR drill to provide quality training. **If you have any comments that the numerical scale does not address, please write your comments on the back of the survey**. Upon completion, please return this form to LT Coughlin.

---

1. Rate the method which provides a more realistic means of simulating an actual shipboard damage control environment.

	IDCTT					**Neutral**				**CBR Drill**
1	2	3	4	5	6	7	8	9	10	11

2. Rate which method provides the ability for the instructor to provide the most complete post-scenario debrief.

	IDCTT					**Neutral**				**CBR Drill**
1	2	3	4	5	6	7	8	9	10	11

3. Rate the method that produced the greatest level of stress while performing the damage control scenario.

	IDCTT					**Neutral**				**CBR Drill**
1	2	3	4	5	6	7	8	9	10	11

4. Rate which system enabled the instructor to monitor trainee performance more closely.

	IDCTT					**Neutral**				**CBR Drill**
1	2	3	4	5	6	7	8	9	10	11

5. Rate which method you feel will better prepare you for actual casualties that may occur onboard your ship.

	IDCTT					**Neutral**				**CBR Drill**
1	2	3	4	5	6	7	8	9	10	11

6. Rate which method provides an easier means to take action on scenario problems (ie: sound power phones, D.C. plate plotting, installed alarm panels vise computer inputs and computer monitor alarm panels).

	IDCTT					**Neutral**				**CBR Drill**
1	2	3	4	5	6	7	8	9	10	11

7. Rate which method provides scenario information in a manner most closely envisioned during an actual shipboard emergency situation.

	IDCTT					**Neutral**				**CBR Drill**
1	2	3	4	5	6	7	8	9	10	11

8. Rate which method is more effective in teaching damage control skills necessary to combat damage control problems.

	IDCTT					**Neutral**				**CBR Drill**
1	2	3	4	5	6	7	8	9	10	11

9. Rate which system promoted greater learning in the amount of time allocated.

	IDCTT					**Neutral**				**CBR Drill**
1	2	3	4	5	6	7	8	9	10	11

10. If you had access to one method of instruction, rate which system you would prefer.

	IDCTT					**Neutral**				**CBR Drill**
1	2	3	4	5	6	7	8	9	10	11

11. Rate which method inspires you to perform to the best of you ability.

	IDCTT					**Neutral**				**CBR Drill**
1	2	3	4	5	6	7	8	9	10	11

Scenario Topics Ranking

Name ______________________________ Date ______________________________

This ranking is for (circle one): **IDCTT** **CBR Drill**

The following fourteen topics summarize the principal actions necessary to resolve a CBR problem. The training method to which you were exposed emphasized each of the following topics to varying degrees. In the blank space provided to the left of each topic, **rank each topic from 1 to 7** based on how you felt the method (IDCTT or CBR Drill) emphasized the **importance of each topic to complete the damage control problem.** Use the following criteria to express your opinion:

Not at all Important			**Neutral**			**Extremely Important**
1	2	3	4	5	6	7

NOTE: Base you ranking on what the scenario emphasized and not on what you think should be emphasized.

_____ Maintain effective communications.
_____ Keep the chain of command informed.
_____ Proceed through all MOPP Levels.
_____ Set general Quarters, ensure Zebra set.
_____ Activate Countermeasure Wash Down System.
_____ Manage Damage Control Central.
_____ Ensure personnel protective equipment is utilized.
_____ Confirm proper manned and ready reports.
_____ Ensure Circle William set.
_____ Manage personnel casualties.
_____ Locate contamination. Conduct internal/external surveys.
_____ Prioritize casualties.
_____ Coordinate countermeasures and decontamination procedures.
_____ Monitor ship continuously for contamination levels.

IDCTT Source-of-Workload Evaluation

Name ______________________________ Date________________________________
Rank ________________________________

Throughout this experiment rating scales are used to assess your opinions of different task conditions. Scales of this type are extremely useful in attempting to measure attitudes about specific subject matter. In this case we are striving to measure workload. However, the interpretation of such scales can sometimes lead to varying conclusions. For example, some people feel that mental demand is the essential aspect of workload regardless of physical effort. Others feel that strong performance is indicative of low workload, and visa versa. There are also those who feel that frustration level is the true measure of workload. Yet studies have shown that the factors that create levels of workload differ based on the actual task.

The evaluation you are about to perform is a technique that has been developed by NASA to assess the relative importance of six factors in determining how much workload person experiences. The procedure is simple: Read the task descriptions, then mark the scale at the point that reflects the task workload that you experienced. All tasks refer to those you performed while operating the IDCTT Trainer. If you have any questions, please ask them now. Thank you for your participation.

Mental Demand

How much mental and perceptual activity was required (i.e., thinking, deciding, calculating, remembering, etc.)?

Low **High**
1 2 3 4 5 6 7 8 9 10 11

Physical Demand

How much physical activity was required (i.e., pushing, pulling, turning, controlling, activating, etc.)?

Low **High**
1 2 3 4 5 6 7 8 9 10 11

Temporal Demand

How much time pressure did you feel due to the rate or pace at which the tasks occurred?

Low										**High**
1	2	3	4	5	6	7	8	9	10	11

Performance Demand

How successful do you thing you were in accomplishing the goals of the tasks set by the researcher (or yourself)?

Low										**High**
1	2	3	4	5	6	7	8	9	10	11

Effort Demand

How hard did you have to work (mentally and physically) to accomplish your level of performance?

Low										**High**
1	2	3	4	5	6	7	8	9	10	11

Frustration

How insecure, discouraged, irritated, stressed, and annoyed did you feel during the tasks?

Low										**High**
1	2	3	4	5	6	7	8	9	10	11

IDCTT User Interface Dimensions Survey

Name ___________________ Date_____________________

Rank ____________________

A number of statements, which describe the interactive courseware (ICW), are given below. Please read each statement then circle the number that reflects your opinion. There are no right or wrong answers.

Dimension 1 – Ease of Use
(Perceived facility with which the user interacts with the ICW)

Difficult										**Easy**
1	2	3	4	5	6	7	8	9	10	11

Dimension 2 – Navigation
(Perceived ability to move through the contents of the ICW)

Difficult										**Easy**
1	2	3	4	5	6	7	8	9	10	11

Dimension 3 – Cognitive Load
(Perceived degree that the user interface seemed manageable)

Unmanageable										**Manageable**
1	2	3	4	5	6	7	8	9	10	11

Dimension 4 – Mapping
(Programs ability to track and graphically represent the user path through the program)

None										**Powerful**
1	2	3	4	5	6	7	8	9	10	11

Dimension 5 – Knowledge Compatibility
(Concepts and relationships that represent the users knowledge of the topic)

Incompatible										**Compatible**
1	2	3	4	5	6	7	8	9	10	11

Dimension 6 - Information Presentation
(Perceived degree that the information contained in the ICW is presented in understandable form)

Unclear										**Clear**
1	2	3	4	5	6	7	8	9	10	11

Dimension 7 – Media Integration
(How much does the ICW coordinate the different media to produce an effective simulation)?

Uncoordinated										**Coordinated**
1	2	3	4	5	6	7	8	9	10	11

Dimension 8 – Overall Functionality
(Perceived utility of the ICW in relation to the program's intended use

Dysfunctional									**Highly Functional**	
1	2	3	4	5	6	7	8	9	10	11

Grade Sheet for IDCTT and CBR Drill Scenarios

Trainees Name (DCA)____________________ Date ____________
Trainees Name (RPL)____________________
Instructors Name (DCTT/ATG)________________
Method of Training (Circle One) **IDCTT** **CBR Drill**

The following is a grade sheet for IDCTT and CBR Drill training. The results will be used for research purposes only. This performance evaluation will be used for the sole purpose of comparing the IDCTT and CBR Drill methods. Maximum points allowed for each action are indicated in parentheses next to each action. Partial credit may be awarded when actions are taken but not completely or correctly executed. The instructor will determine the partial credit and assign points accordingly.

Actions before and during attack:

MOPP-1:

1. Ensure personal protective equipment was issued. _____ (5)

2. Ensure material condition yoke was set. _____ (3)

MOPP-2:

3. Ensure personnel carried protective masks. _____ (5)

4. Pre-position CBR-D equipment IAW CBR-D bill. _____ (5)

5. Op-test CMWD system and alarms. _____ (5)

6. Post M8/M9 paper (chemical/biological). N/A _____ (5)

7. Issue personal dosimeters (radiological). N/A _____ (5)

8. Order/ensure material condition zebra set. _____ (5)

MOPP-3:

9. Order/ensure personnel don protective suit; carry gloves/mask (chemical/biological).	N/A	_____	(5)
10. Issue medical supplies (chemical/biological).	N/A	_____	(5)
11. Operate AN/KAS-1 continuously (chem./bio.).	N/A	_____	(5)
12. Monitor CAPDS continuously (chemical/biological).	N/A	_____	(5)
13. Warm up radiacs (radiological).	N/A	_____	(5)
14. Direct personnel to take ready or deep shelter (radiological).	N/A	_____	(5)
15. Activate CPS.		_____	(5)
16. Set General Quarters.		_____	(5)
17. Activate CMWD system intermittently.		_____	(2)
18. Ensure CCA/decon stations manned and ready.		_____	(5)

MOPP-4:

19. Operate CMWD system continuously.		_____	(5)
20. Order/ensure personnel don protective mask, gloves.		_____	(5)
21. Order/ensure material condition circle william set.		_____	(5)
22. Implement mandatory water drinking.		_____	(5)
23. Continuously monitor all radiation detection equipment (radiological).	N/A	_____	(5)

24. Set MPE and casualty dose (radiological). N/A _____ (5)

Actions after attack:

25. Coordinate internal/external surveys and conduct decontamination procedures. _____ (3)

Overall:

26. Respond in a timely manner to prompting by the bridge, CIC, etc. _____ (2)

27. Maintain the big picture of the damage and circumstances that he was combating. _____ (3)

28. Keep the Commanding Officer/bridge informed on the status of damage control efforts. _____ (2)

TOTAL POINTS SCORED _____ (100)

Comments:

APPENDIX C: WILCOXON SIGNED-RANK TEST CALCULATIONS

Null Hypothesis: H_0 The population relative frequency distribution for the IDCTT trainer performance scores and traditional CBR drills performance scores are identical.

Alternative Hypothesis: H_1 : The population relative frequency distribution of the IDCTT trainer performance scores are greater than the CBR drill performance scores.

Data:

W = Rank sum of positive differences = 214.5
n = 22

Note: Table 23 contains the differences and rank scores for 24 training events. The events that resulted in a difference equal to zero are no included in the calculations.

Test Statistic: $z = 2.86$

$$z = \frac{W-(n(n+1)/4)}{[n(n+1)(2n+1)/24]^{1/2}}$$

Rejection Region: Reject H_0 if $z \geq z_\alpha$

$z = 2.86$
$z_\alpha = 1.96$ at the .025 significance level.

Conclusion: Reject the null hypothesis at the .025 significance level. The distribution of performance scores for the IDCTT trainer is higher than the distribution of performance scores for traditional CBR drills.

Table 22: Trainee Graded Evolutions.

Scenario	CBR Drill (Rushmore)	IDCTT (Harpers Ferry)
1	88	95
2	82	80
3	77	85
4	96	96
5	98	97
6	83	93
7	90	95
8	81	92
9	85	81
10	87	89
11	96	99
12	89	97
13	83	95
14	91	90
15	89	89
16	96	91
17	90	89
18	88	91
19	92	96
20	79	88
21	85	93
22	92	90
23	87	96
24	93	97
25	85	--
26	91	--

Table 23: CBR Drill and IDCTT Wilcoxon Rankings.

CBR Drill/IDCTT Scenario	Score Difference	Wilcoxon Rank
1	+7	+14.0
2	- 2	-5.00
3	+8	+16.5
4	0	------
5	- 1	-2.00
6	+10	+20.0
7	+5	+12.5
8	+11	+21.0
9	- 4	-10.00
10	+2	+5.00
11	+3	+7.50
12	+8	+16.5
13	+12	+22.0
14	- 1	-2.00
15	0	------
16	- 5	-12.5
17	- 1	-2.00
18	+3	+7.50
19	+4	+10.0
20	+9	+19.0
21	+8	+16.5
22	- 2	-5.00
23	+8	+16.5
24	+4	+10.0

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